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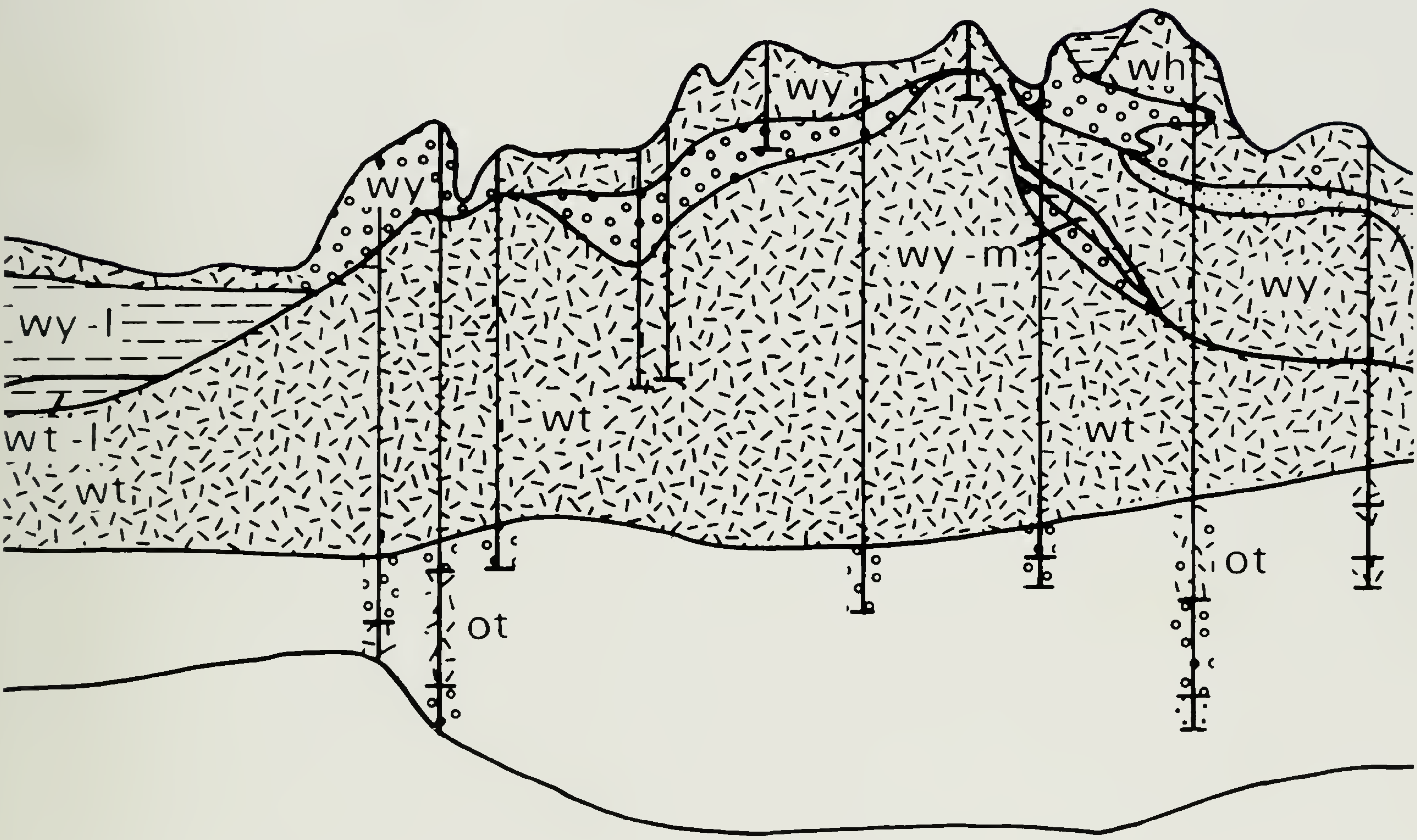
REGIONAL GEOLOGY OF THE TISKILWA TILL MEMBER, WEDRON FORMATION, NORTHEASTERN ILLINOIS

Susan Specht Wickham
W. Hilton Johnson
Herbert D. Glass



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Cover design: Segment of cross section D-D′ showing Barlina Moraine and West Chicago Moraine (from figure 8d, page 18).

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Errata

Circular 543: Regional geology of the Tiskilwa Till Member, Wedron Formation, northeastern Illinois, by Susan Specht Wickham, W. Hilton Johnson, and Herbert D. Glass

Title page: W. Hilton Johnson, professor of geology at the University of Illinois at Urbana-Champaign, is an ISGS research affiliate.

Page 1:	line 3: for Subage, read Substage
13:	(legend), for organic salt, read organic silt; for Tuskilwa, read Tiskilwa
17:	in column head, for % Kaolinite > chlorite read % Kaolinite + chlorite
17:	(table 4), for σ, read s
24:	(figure 9), for σ, read s
25:	(figure 10), for σ, read s

FIGURES

TABLES

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REGIONAL GEOLOGY OF THE TISKILWA TILL MEMBER, WEDRON FORMATION, NORTHEASTERN ILLINOIS

ABSTRACT

The Tiskilwa Till Member, the oldest unit of the Wedron Formation in northern Illinois, was deposited during the early part of the Woodfordian Subage. The wedge-shaped unit is 200 to 300 feet (60 to 90 m) thick in end moraines and 50 to 100 feet (15 to 30 m) in ground moraine areas. Basal till of the Tiskilwa is relatively uniform in composition and texture over a wide area, but a lower zone of basal till and an upper zone of supraglacial till and related deposits are more variable. These zones, contrasting in composition from the main body of Tiskilwa, are herein termed as having a mixed composition. The lower zone is interpreted to reflect local entrainment and mixing of bedrock and older drift with debris entrained farther up-ice.

The sub-Tiskilwa surface has little relief and slopes eastward toward the Lake Michigan Basin. The margin of the Tiskilwa ice sheet was in an enhanced compressive flow regime, and as a result, large amounts of ice and debris were stacked near the ice margin during deposition. Active ice deposition took place over an interval of several thousand years when the southern portion of the Laurentide Ice Sheet was becoming progressively larger.

The Tiskilwa Till Member was deposited by ice of the Harvard and Princeton Sublobes of the Lake Michigan Lobe. The sublobe configuration probably was not controlled by sub-ice topography, but rather by temporal variations in the influence of the Huron-Erie Lobe on flow and configuration of the Lake Michigan Lobe.

Tiskilwa Till surface morphology influenced later ice events and many palimpsest end moraines developed with a core of Tiskilwa Till. Till units younger than the Tiskilwa—the Malden, Yorkville, and Haeger Till Members—are thinner, and have both typical and mixed compositions. They were deposited over a relatively short time interval during general deglaciation, when supraglacial and ice-marginal resedimentation processes were more active than during deposition of Tiskilwa Till.

INTRODUCTION

The distinctive Tiskilwa Till Member of the Wedron Formation is an early Woodfordian till in northeastern Illinois; it is the thickest till unit in Illinois and possibly one of the thickest till units in the United States. End moraine thicknesses commonly exceed 200 feet (60 m), and typical ground moraine thicknesses range from 50 to 100 feet (15 to 30 m). One of the more extensive till units, it is found at the surface and in the subsurface of at least ten counties in northeastern Illinois and extends northward into Wisconsin (Mickelson et al., 1984). The Marengo Moraine and the Bloomington Morainic System (Willman and Frye, 1970), which are composed of Tiskilwa Till, intersect almost at right angles. The Tiskilwa Till Member has a distinctive loam texture, pink color, and clay mineral composition that contrast sharply with younger gray, silty, and clayey tills of the Wedron Formation.

This investigation was undertaken to answer the following questions:

- Do surface and subsurface studies support a two-lobe (Princeton and Harvard Sublobes) explanation for the configuration of the Marengo and Bloomington Moraines?
- Is the Tiskilwa Till homogeneous over its entire thickness and extent? If not, do vertical and regional compositional trends exist?
- What are the relationships between the Tiskilwa Till topography and thickness, and the bedrock surface and the underlying drift surface topography?
- How is the Tiskilwa Till related to the superjacent and subjacent till units?

A brief summary of data from this study and further inferences with regard to the depositional origin of Tiskilwa Till are in Wickham and Johnson (1981).

The data were also used for preliminary studies for siting the proposed Superconducting Super Collider in Illinois (Kempton et al., 1985).

Location

The study area encompasses a major portion of McHenry, Kane, and De Kalb Counties and small portions of three surrounding counties—Kendall, Lee, and Ogle—in Illinois (fig. 1). It is bounded on the east by the Fox River, on the south by T37N, on the north by the Wisconsin state border, and on the west by the western boundary of the Tiskilwa Till Member (Marengo Moraine and Bloomington Morainic System) and R2E in Lee County.

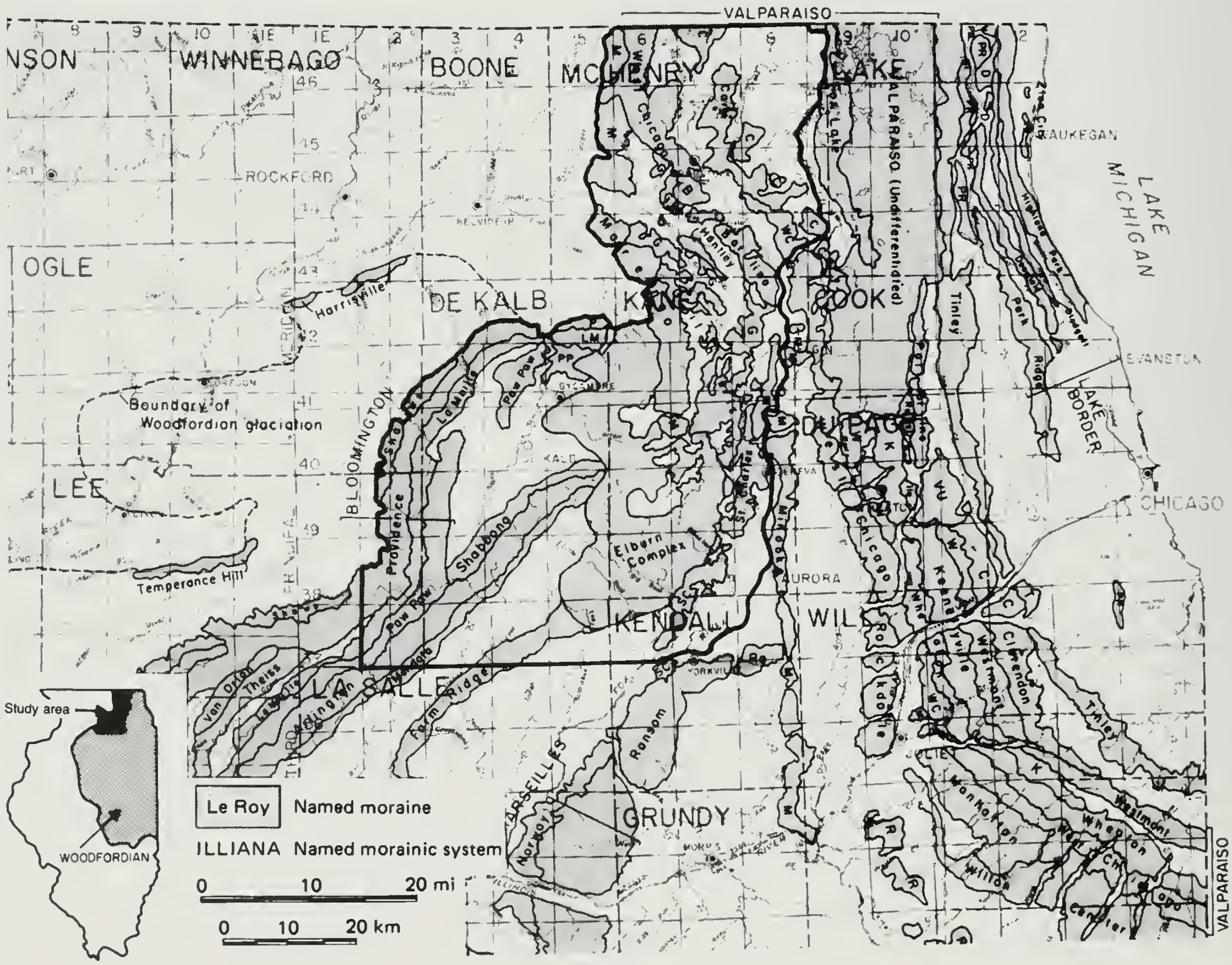


Figure 1 Location of study area with respect to Woodfordian end moraines in northern Illinois (modified from Willman and Frye, 1970).

Previous work

The glacial geology of northern Illinois was first studied by Chamberlin (1882, 1894) and Leverett (1899). Their major contributions included mapping the geomorphic features and interpreting the glacial history of the area. Leighton (1931, 1933; Leighton et al., 1931) used part of the study area as the basis for classification of the Wisconsinan episode of glaciation, and interpreted its glacial geology.

Numerous mapping revisions and interpretations of the surficial deposits throughout northeastern Illinois have since been published, including Fryxell (1927), Bretz (1939), Ekblaw (1941, 1959), Ekblaw and Lamar (1964), Block (1960), Anderson and Block (1962), and Anderson (1964). More recent investigations have been county studies of a stratigraphic nature, regional summaries, and geologic mapping, primarily for applied geologic research; these include Kempton (1963), Gross (1969), Hackett and McComas (1969), Gross (1970), Willman (1971), Kempton et al. (1977), and Lineback (1979). The most recent stratigraphic classification and general description of units is found in Willman and Frye (1970). Modifications of the regional stratigraphic sequence are suggested and discussed in Johnson et al. (1985) and Berg et al. (1985).

Methods

This study emphasizes interpretation of subsurface data. Most data (such as water well logs and cuttings, test hole logs and cores, engineering logs and cores, and field notes) were obtained from records and samples on file at the Illinois State Geological Survey. Additional information and data were obtained from field observations, analysis of samples acquired with a Giddings hydraulic soil probe, and study of soil reports. Subsurface samples from more than 530 sites were utilized in addition to numerous well logs without sample control (table A, appendix).

All samples were described in terms of texture, Munsell color, structure, other distinctive features, and reaction to hydrochloric acid. Selected samples were also analyzed for matrix grain size and clay mineral and carbonate composition. All analytical data are on open file at the Illinois State Geological Survey and data for the Tiskilwa Till Member are reported in Wickham (1979).

Grain-size analyses were performed by the Illinois State Geological Survey Geotechnical Laboratory, using standard sieve and hydrometer techniques. Data are reported as percentage of gravel in the whole sample, and percentage of sand (2.00 to 0.062 mm), silt (0.062 to 0.004 mm), and clay (less than 0.004 mm) in the matrix (all material less than 2.00 mm).

The clay mineral identification was done by X-ray diffraction methods, using oriented aggregate, glycolated slides of less than 0.002-mm material. Clay minerals were separated into three groups and quantitatively calculated, using peak height measurement (counts per second) from a logarithmic scale. These three groups were defined by Willman, Glass, and Frye (1966) as

- *expandable clay minerals*: all materials that expand to approximately 17 Å when solvated with ethylene glycol; includes low-charge vermiculite and montmorillonite (smectite)
- *illite*: clay minerals with 10 Å basal spacing that do not expand when treated with ethylene glycol
- *kaolinite plus chlorite*: all clay minerals with a 7.2 Å basal spacing.

Calcite and dolomite in the <0.002-mm fraction were measured by peak height (counts per second) to obtain relative quantities of these minerals.

Two additional measures of clay mineral variables were used for this study: Diffraction Intensity Ratio and Vermiculite Index. The Diffraction Intensity Ratio (D.I.) measures the ratio of the intensity of the 10 Å illite peak to the 7.2 Å kaolinite-plus-chlorite peak (Frye, Glass, and Willman, 1962). According to Willman, Glass, and Frye (1966, p. 20), "As kaolinite is generally unaltered during the weathering process, variations in the ratio (D.I.) indicate changes in the proportions of illite and chlorite." In Woodfordian tills, the D.I. ratio increases upward in the weathering profile because the intensity of weathering has not been sufficient to alter illite in these young materials. Older tills may show an upward increase in D.I. ratio because of the alteration of chlorite, then a decrease in D.I. ratio as a result of the alteration of illite and a decrease of the 10 Å illite reflection (Willman, Glass, and Frye, 1966). The D.I. is a useful parameter for differentiating unaltered and altered clay minerals.

The Vermiculite Index (V.I.) is the vertical difference (in mm) between the 14 Å chlorite or vermiculite peak and the 10 Å illite peak. A greater-than (>) number indicates that the 14 Å peak is larger; a less-than number (<) indicates that it is smaller. The Vermiculite Index is used in stratigraphic interpretation and as a measure of chlorite alteration by weathering. The chlorite diffraction peak at 14 Å will increase in intensity with alteration to vermiculite.

The amount of calcite and dolomite in the <0.074-mm fraction was determined on selected samples with the Chittick gasometric apparatus, following procedures described by Dreimanis (1962).

Stratigraphic nomenclature

Willman and Frye (1970) established a multiple stratigraphic classification for Pleistocene deposits and formally defined many units in Illinois. The Tiskilwa Till Member currently is considered to be the oldest unit of the Wedron Formation in northern Illinois; it is in the lower portion of the Woodfordian Substage of the Wisconsinan Stage (fig. 2).

Willman and Frye (1970) defined the Lee Center Till Member as the oldest unit of the Wedron Formation in northern Illinois. Recent studies in the type area of the Lee Center, however, indicate that it is Illinoian and significantly older than the Wedron Formation (Kempton et al., 1985). Deposits below typical Tiskilwa Till that previously had been correlated with Lee Center Till have been included as a lower unit in the Tiskilwa (Wickham and Johnson, 1981; Johnson et al., 1985), and that practice is followed in this report.

The Tiskilwa Till Member was named for the town of Tiskilwa, Bureau County; the type section, the Buda East Section, is a roadcut, in SE¼ SE¼ SE¼, Sec. 31, T31N, R8E, Bureau County, 5 miles northwest of Tiskilwa (Frye and Willman, 1965, p. 65, unit 1). In the type section the Tiskilwa

Till is overlain by sand and gravel of the Henry Formation, which is overlain by Richland Loess (Willman and Frye, 1970, p. 68).

Tiskilwa Till (called Marengo or Bloomington till in reports prior to 1970) is a pink-tan to reddish gray-brown sandy or sandy-silty (loam) till (Willman and Frye, 1970), and is commonly called a pink sandy clay by drillers. It typically has an oxidized color of pinkish orange to pink-tan and a weathering profile 5 to 10 feet (1.5 to 3 m) deep when it appears at or near the land surface. Below the zone of oxidation it commonly appears gray with a reddish hue.

Tiskilwa Till overlies Morton Loess, Robein Silt or older glacial tills of the Winnebago and Glasford Formations (fig. 2). It is overlain by Richland Loess, Henry Formation (glaciofluvial deposits), Equality Formation (glaciolacustrine deposits) or a younger till member of the Wedron Formation (fig. 2).

Classification of till

A genetic classification of till is developing from observations of the mode of transport and deposition of till by modern glaciers and through study of the characteristics of ancient till deposits. In this report, the term till is used in a broad sense to include materials deposited directly by the glacier, as well as unsorted deposits that have been modified in the glacial environment through mass wasting processes. Two main categories of till are recognized: supraglacial till, deposited on or from the surface of a glacier as a result of surface melting; and subglacial or basal till, deposited beneath a glacier (Dreimanis, 1981).

Supraglacial till is deposited on or adjacent to a stagnant glacier or in the terminal zone of an active glacier. Boulton (1970b and 1972a) recognized two types of supraglacial till: *flow till*—material deposited from a sediment flow, and *melt-out till*—material that melts out from stagnant ice. Dreimanis (1976) and Boulton (1971) observed that supraglacial till is thinner and texturally more variable than basal till. It commonly is interbedded with sorted silt, sand, and gravel.

Basal or subglacial till is classified by mode of deposition as *basal melt-out till*, and *lodgement till* (Dreimanis, 1976). Basal melt-out till (Boulton, 1970a, 1972b) is deposited by melting of inactive basal ice; it commonly is more dense than supraglacial melt-out till because of the overlying ice and debris load during deposition. The structure of basal melt-out till reflects the character of basal or englacial debris. Lodgement till is deposited by pressure-melting, basal melt-out, and physical lodging of basal debris onto the bed below an actively moving glacier.

It is not always possible to distinguish between supraglacial and basal till in the Tiskilwa sequence on the basis of subsurface evidence; therefore, the genetic classification has been used in this report only in places where a definite sequence and origin of materials are evident. More variable deposits associated with sorted or semisorted materials have been delineated as supraglacial till; however, some of the more homogeneous, uniform till in the sequence may also have originated in the supraglacial environment.

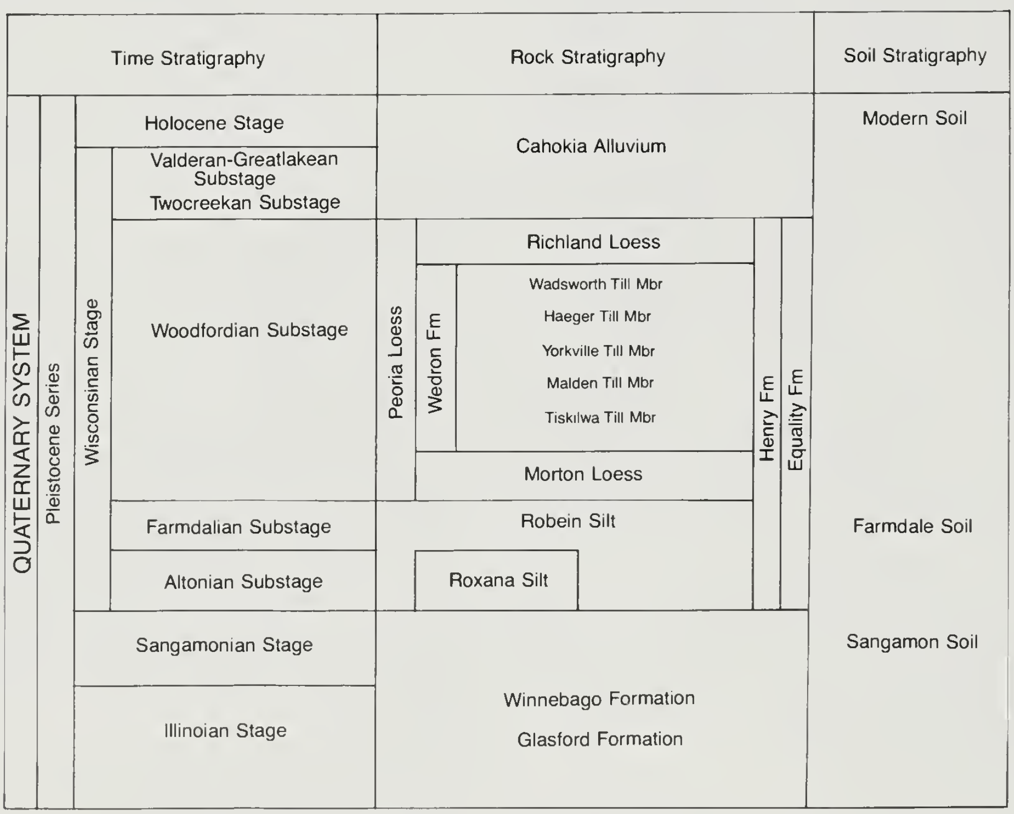


Figure 2 Selected Quarternary stratigraphic units in northern Illinois (modified from Willman and Frye, 1970; Kempton et al., 1985; and Krumm and Berg, 1985).

GEOMORPHOLOGY

Glacial features in the study area are the result of deposition by the Harvard and Princeton Sublobes of the Lake Michigan Lobe (fig. 3). The four outer moraines—the Shaws, Providence, La Moille, and Paw Paw—in the Bloomington Morainic System (Princeton Sublobe) have a lobate form and intersect the north-south trending Marengo Moraine (Harvard Sublobe) to form an abrupt reentrant (fig. 1). The younger Shabbona, Arlington, Mendota, and Farm Ridge Moraines of the Princeton Sublobe also have a lobate form, but a slightly different orientation than the older Bloomington System.

The moraines of the Harvard Sublobe trend north-south and northwest-southeast. The Minooka and St. Charles Moraines of the Joliet and Princeton Sublobes, respectively, also extend in a north-south direction parallel to the Fox River and to younger moraines to the east.

The two most prominent moraines in the study area are the Providence and Marengo; both attain heights of 150 to 200 feet (45 to 60 m) above the older till and outwash plains to the west. Younger moraines, the Paw Paw and West Chicago, respectively, overlie the backslopes of these larger moraines. In much the same way, but on a smaller scale, the large Arlington Moraine is overlapped on its backslope by the smaller Mendota Moraine. Most of the younger moraines are of relatively low relief and are locally indistinct.

The Elburn Complex, consisting of kames and kame complexes, eskers, ice-contact ridges, ice-block lakes, large lake basins, and hummocky drift plains, lies among moraines with different orientations related to different sublobes, and covers a substantial portion of Kane County. Many of these features have alignments and internal characteristics that suggest relationships to adjacent morainic features, but they are so variable and complex that individual moraine differentiation is difficult.

Four of the Bloomington System moraines and the Marengo Moraine are composed of Tiskilwa Till; they differ primarily in size and orientation. The Marengo Moraine is the highest topographic feature in northeastern Illinois, reaching an elevation of more than 1100 feet (335 m). The moraine consists of one north-south trending ridge, about 3 miles (4 km) wide, that has moderate to irregular slopes and many local knobs and depressions. The Marengo, with its single crest, is steeper and higher than any moraine in the Bloomington System. Lobes of sediment flow deposits occur along its front in McHenry County but are not as common in the Bloomington System in this area.

The outermost ridge of the Bloomington System, the Shaws Moraine, is a low bench less than 1 mile wide (1.6 km) and 50 to 100 feet (15 to 30 m) higher than the drift surface to the west. Rising more than 100 feet (30 m) above the Shaws is the Providence Moraine; the La Moille moraine, of lower elevation, and the discontinuous Paw Paw Moraine lie to the east. Local relief within the Bloomington moraines generally is less than that in the Marengo, but ice-disintegration features are locally prominent. Surface features have been masked by younger drift deposits in the eastern and southwestern portions of the study area and modified by periglacial processes (Flemal et al., 1973) in north-central De Kalb County.

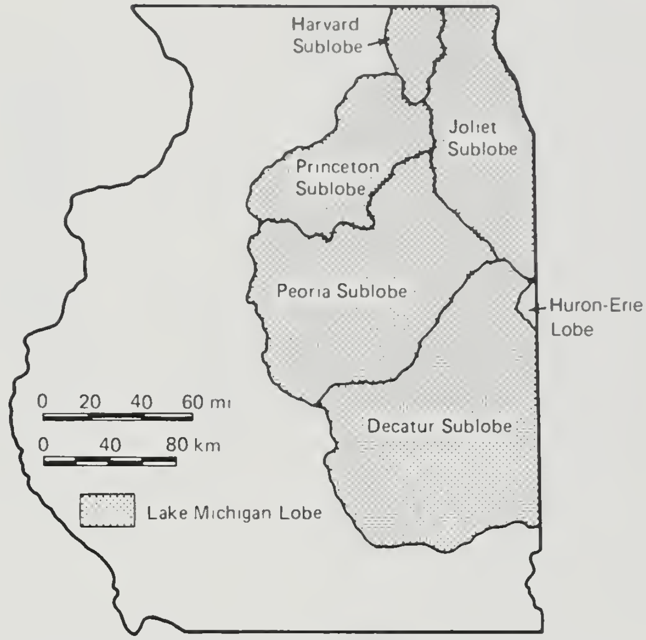


Figure 3 Woodfordian glacial lobes and sublobes in Illinois (modified from Willman and Frye, 1970).

The Huntley and Barlina Moraines (fig. 1) are composed of clayey tills and are associated with many ice-contact features of low relief and a former ice-dammed lake.

BEDROCK TOPOGRAPHY

The bedrock surface is marked by the Troy, Paw Paw, Rock, and Newark Bedrock Valleys (fig. 4). The ancient divide between drainages flowing west and southward and drainages flowing east and northward extends north-northwest through the area. The drainageways flowing east and northward were broad, shallow troughs with low gradients; they were probably connected to the St. Lawrence drainage system. The drainageways flowing west and southward were deep bedrock valleys that were part of the Ancient Mississippi Valley drainage system. The Rock and Troy Bedrock Valleys are parallel; they pass beneath the Bloomington Morainic System and join to form the Paw Paw Valley in southeastern Lee County.

The highest elevation of the bedrock surface—more than 850 feet (259 m)—is in the northwest corner of McHenry County (fig. 4). Plateaus more than 800 feet (244 m) high occur west of the Tiskilwa boundary (approximately paralleling the Marengo-Bloomington Moraines), and also in T41N, R6E, Kane County. Bedrock locally crops out just west of the study area, in northwestern De Kalb County, and along the Fox River. The general slope of the bedrock surface is about 5.5 feet per mile (0.9 m/km) from west-northwest to east-southeast, approximately parallel to the regional dip of the bedrock.

The bedrock surface is polygenetic and probably contains some features that may be preglacial in origin. Most features, however, probably formed after early glaciation. The surface consists of fluvial landforms that have been modified by glacial erosion.

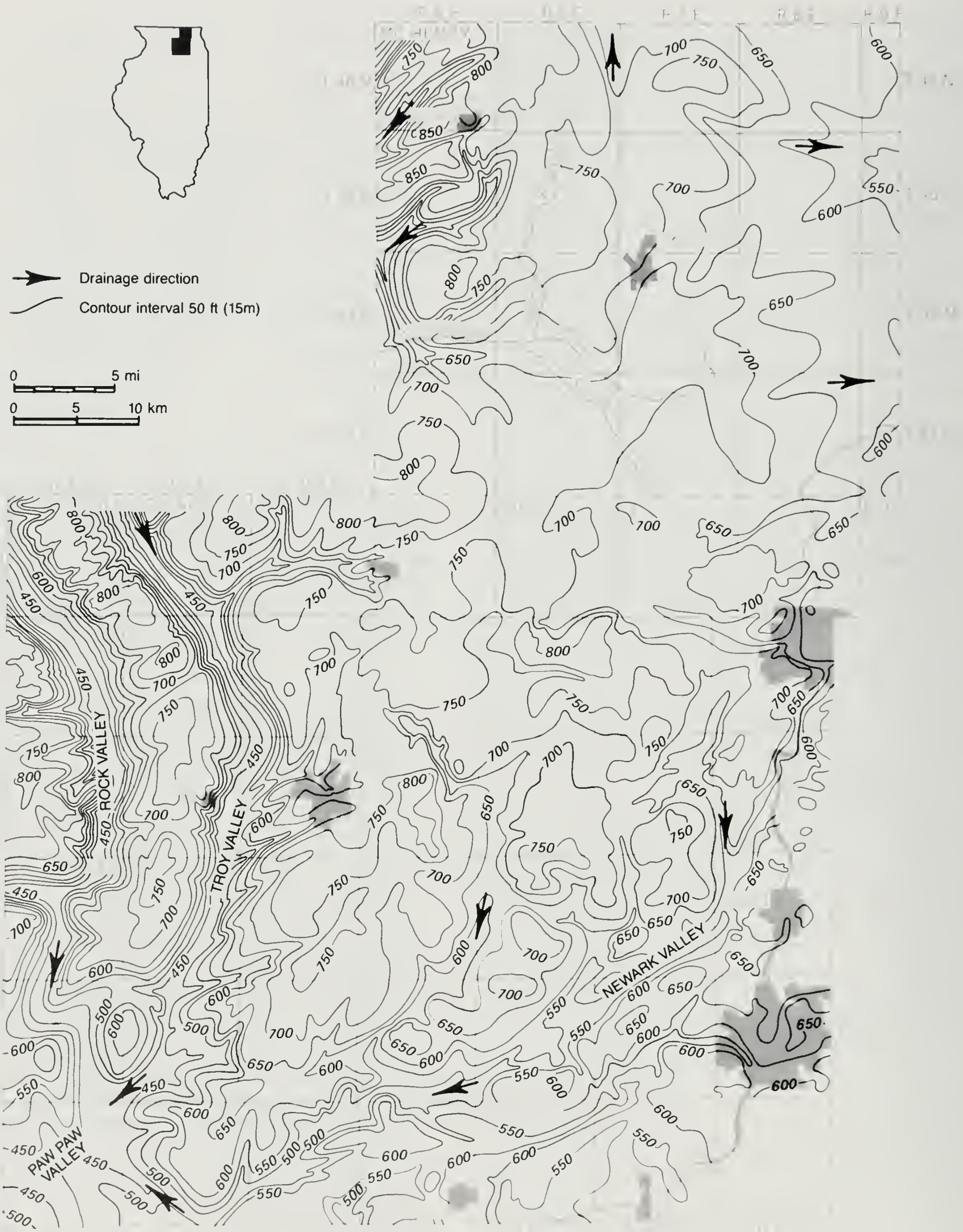


Figure 4 Topography of the bedrock surface (compiled and modified from McGinnis et al., 1963, and unpublished map by R. H. Gilkeson).

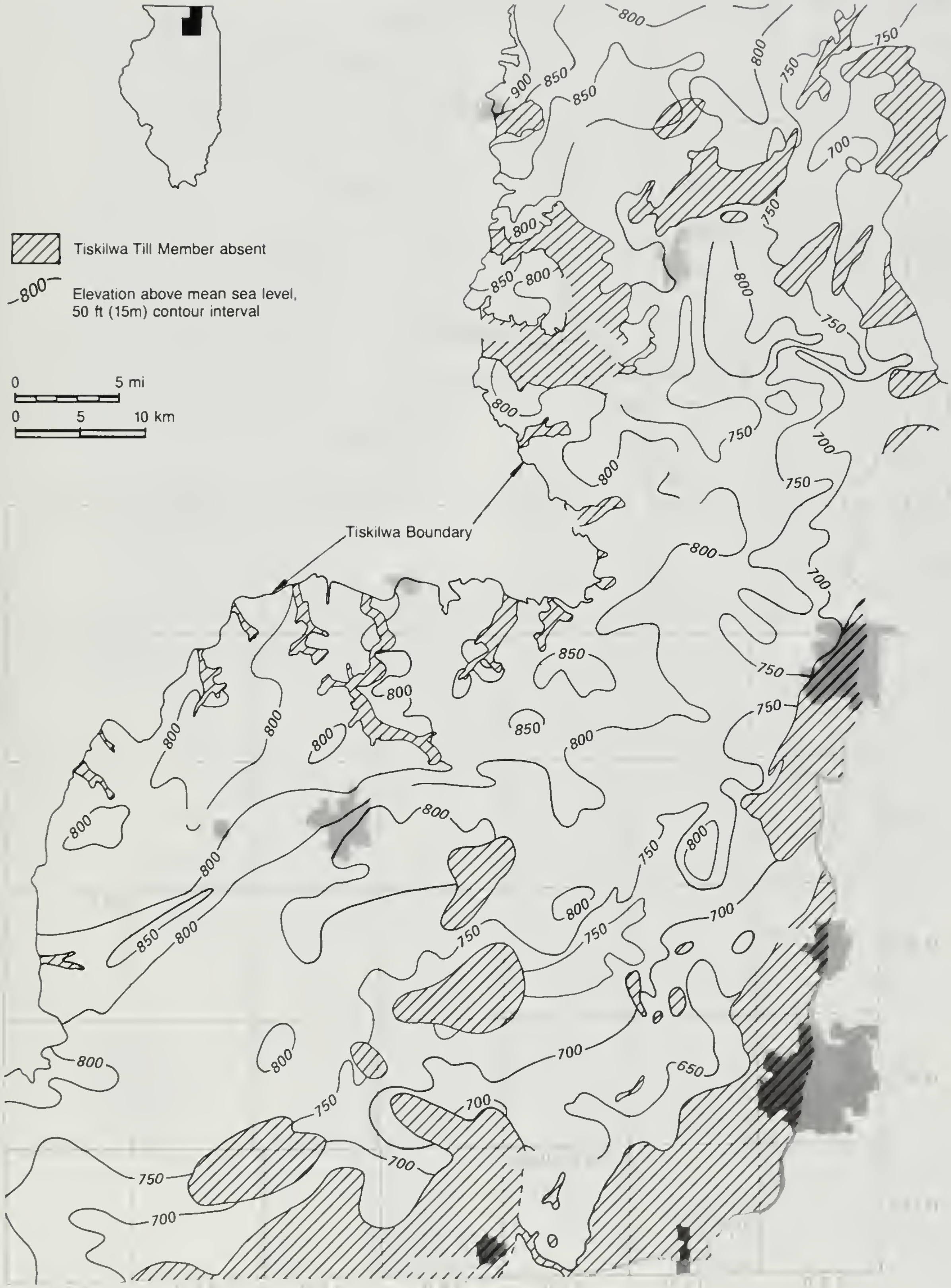


Figure 5 Topography of the sub-Tiskilwa Till surface.

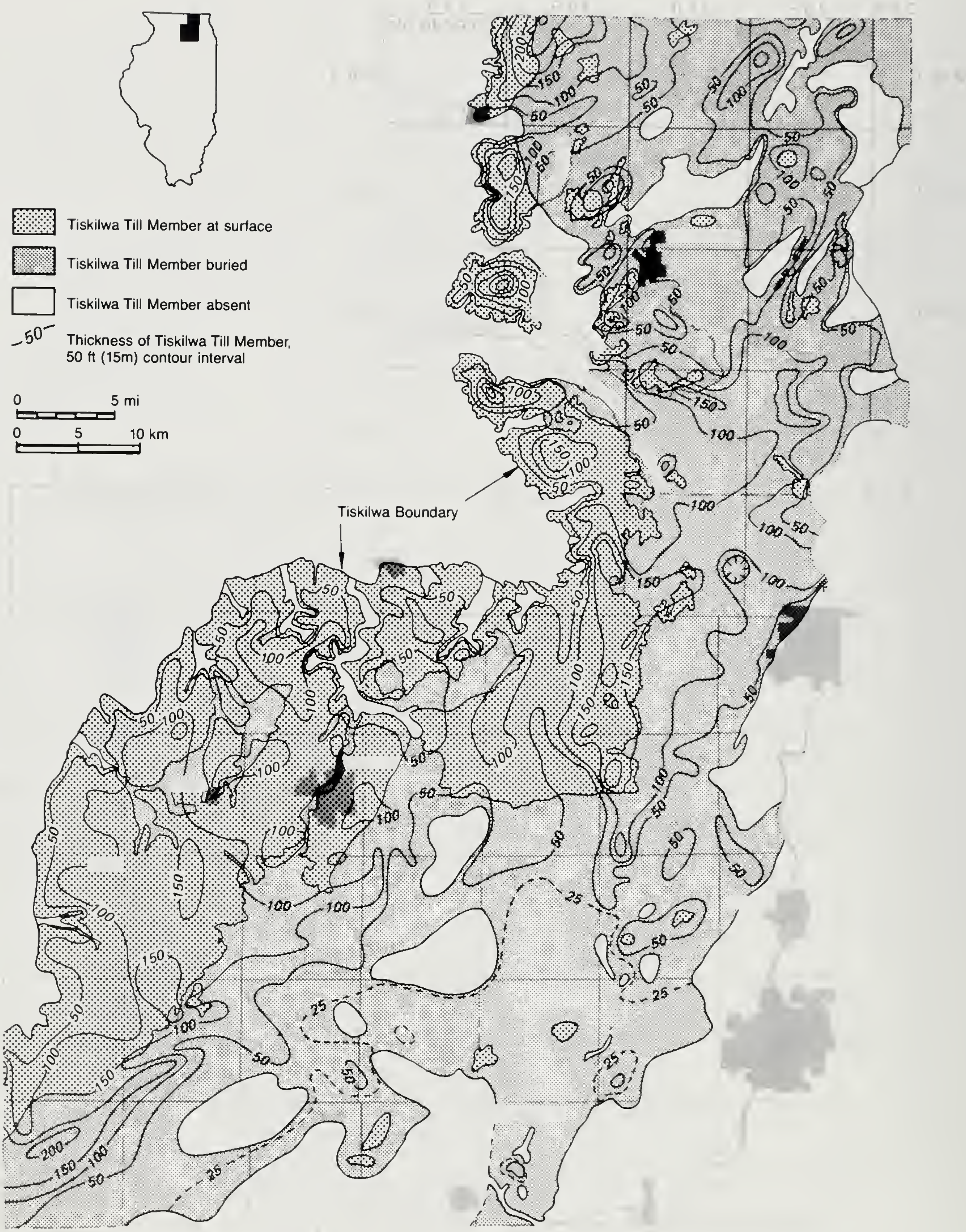


Figure 6 Thickness of Tiskilwa Till Member.

SUB-TISKILWA DEPOSITS

Stratigraphy of sub-Tiskilwa units

Deposits below the Tiskilwa consist mainly of older till, outwash, and accretionary silt deposits. Some of the outwash may be pro-Tiskilwa in origin, but it is included with the older outwash when it cannot be differentiated on a stratigraphic basis. Bedrock also occurs locally below the Tiskilwa.

The older till deposits are thin and discontinuous where they have been truncated or completely eroded by succeeding glacial advances. Bedrock valleys, such as the Paw Paw, Troy, and Rock, contain a more complete sequence of deposits than do the surrounding upland areas. The age of the older deposits ranges from early Woodfordian (pro-Tiskilwa) to Illinoian and possibly older (Frye et al., 1969; Kempton and Hackett, 1968; Kempton et al., 1985). Cross sections (figs. 7, 8a-h) show these deposits as undifferentiated older till (ot) or undifferentiated older outwash (ou).

Deposits of outwash sand or sand and gravel locally occur directly beneath the Tiskilwa Till throughout the study area. They are commonly less than 10 feet (3 m) thick, but are as much as 40 feet (12 m) thick in some places in central De Kalb, central Kane, and northern McHenry Counties.

The organic zones and buried soil profiles that occur at the sub-Tiskilwa Till surface are Farmdale Soil developed in Robein Silt (Willman and Frye, 1970). The Robein Silt, an organic, accretionary silt, occurring over much of the area, is overlain by the Tiskilwa Till or Tiskilwa-related lacustrine or outwash deposits. Dated organic materials from Robein silt range from approximately 23,000 to more than 50,000 radiocarbon years B.P. in northern Illinois (Curry and Krum, 1986) (appendix, table B).

Topography of the sub-Tiskilwa surface

The topography developed on sub-Tiskilwa deposits (fig. 5) represents a composite of the geomorphic surfaces that existed prior to the advance of the Tiskilwa glacier and erosional modifications that were a result of that glacial event. An integrated drainage system is not apparent on this surface. The surface, characterized by a few broad "lows" and "highs," has no major drainage divide; it slopes gently to the east and southeast, has a total relief of about 150 to 200 feet (45 to 60 m), and reflects the general slope of the regional bedrock surface and structure.

The prominent bedrock valleys (fig. 4) are not revealed on the sub-Tiskilwa surface (fig. 5), although a shallow low area occurs above some of the tributaries. The bedrock valleys were filled to a level approximately equal to surrounding uplands, creating a fairly level surface prior to deposition of the Tiskilwa Till (fig. 8f). Lacustrine silts interbedded with outwash, probably related to Tiskilwa or older glacial advances, occur locally in the uppermost portions of the bedrock valley fill in De Kalb and Ogle Counties (fig. 8f).

TISKILWA TILL MEMBER

Thickness

The thickness of the Tiskilwa Till Member is highly variable. The mapped thickness (fig. 6) includes basal till, supraglacial till, and interbedded zones of lacustrine, fluvial, and ice-contact deposits. Fluvial and lacustrine deposits directly above and below the Tiskilwa that are not clearly related to the Tiskilwa have not been included.

Tiskilwa Till is thickest beneath the Marengo Moraine and the Bloomington Morainic System (figs. 8a, 8h). In the northwestern corner of McHenry County, the Tiskilwa is locally thicker than 300 feet (90 m); here the underlying bedrock and sub-Tiskilwa surfaces are also at their highest elevation. The till generally thins southward and eastward; in southern Kane, northern Kendall, and southern De Kalb Counties, Tiskilwa Till is generally absent (fig. 6).

The entire length of the Marengo Moraine, including that portion south of the reentrant with the Bloomington System, is underlain by Tiskilwa Till averaging 200 feet (60 m) or more in thickness. The Tiskilwa thins where it is buried by younger deposits, but a ridgelike feature of Tiskilwa is still present in the subsurface in central Kane County (fig. 6).

The Bloomington Morainic System is composed of Tiskilwa Till averaging 100 to 150 feet (30 to 45 m) in thickness, about 50 to 100 feet (15 to 30 m) less than that beneath the Marengo Moraine. The Bloomington System is up to 8 miles (12.8 km) wide, whereas the Marengo is generally less than 4 miles (6 km) wide. The greatest thickness of Tiskilwa Till in the Bloomington System occurs in the Paw Paw Moraine (the innermost moraine in the system), part of which overlies the Troy and Paw Paw Bedrock Valleys; however, other portions of the Paw Paw Moraine overlie bedrock upland areas.

In McHenry County, several ridgelike features composed of Tiskilwa Till occur in the subsurface. An arcuate feature (fig. 6) occurs beneath and in front of the West Chicago Moraine (fig. 8d). A second, discontinuous ridgelike feature trends north-south on the eastern edge of McHenry County. Other smaller ridges have streamlined shapes and northeast-southwest orientations; they appear to be drumloid features. These features are probably erosional remnants of a more uniformly thick till sheet or of depositional ridges, such as end moraines, which were eroded, streamlined, and buried during subsequent glacial events.

The thinning and absence of Tiskilwa Till beneath areas of younger glacial deposits is attributed to fluvial and glacial erosion. Meltwaters flowing along the Fox River have substantially eroded the till present in the valley, especially in Kane County and northern Kendall County. Large portions of this area along the river contain valley train deposits over bedrock. In southern Kane County, where the Tiskilwa is less than 25 feet (6.5 m) thick and in some places is absent, as is common in southeastern DeKalb County (fig. 6), Tiskilwa Till probably was eroded subsequently by the Tiskilwa and succeeding or younger ice sheets. Later glacial advances incorporated Tiskilwa Till into their load as they advanced westward and upslope.

The northeast-trending linear troughs in McHenry County (e.g., Wonder Lake) are lowlands containing ice-block depressions and ice-contact deposits from the Haeger ice and its meltwater. Gaps in the Marengo Moraine are filled with outwash deposits from Haeger meltwater that form outwash plains. Subglacial channels in the Tiskilwa

ice may have formed gaps in the moraine that became lowlands when the ice melted (Anderson and Block, 1962). These lowlands were later utilized as drainageways by Haeger meltwater, and outwash was deposited in morainic gaps and on the broad plain west of Morengo Ridge.

The easternmost exposure of "pink" till near Joliet in northeastern Illinois was described by Fisher (1925) as consisting of 2 feet (0.6 m) of "highly calcareous pink till" beneath 4 feet (1.2 m) of gray, laminated lake clays and "Minooka Drift" (Yorkville Till). We assume that this "pink" till is probably Tiskilwa. Tiskilwa Till with a maximum thickness of about 40 feet (12 m) has been found locally in the subsurface in Du Page, northern Cook, and Lake Counties. An eastern boundary for pink till (including older Winnebago Formation tills) suggested by Kempton and Hackett (1968) generally corresponds with the eastern boundary of the Tiskilwa shown in figure 6.

A comparison of Tiskilwa Till thickness (fig. 6) with the elevation of the sub-Tiskilwa surface (fig. 5) and bedrock surface (fig. 4) shows no obvious pattern of correspondence. "High" underlying surfaces are covered by both thick and thin Tiskilwa Till; "lows" also contain both thick and thin Tiskilwa Till. The results of deposition of Tiskilwa Till and erosion from succeeding glaciers and their meltwaters must be distinguished before conclusions can be reached concerning reasons for variation in Tiskilwa Till thickness.

To summarize, the Tiskilwa Till is a wedge-shaped deposit that is 200 to 300 feet (60 to 90 m) at its terminus and 50 to 100 feet (15 to 30 m) behind the terminus; its thickness decreases to the east and southeast toward the Lake Michigan Basin. The base of the Tiskilwa Till has fairly low relief and a regional slope to the southeast. Major thickness variations resulted primarily from the formation of end moraines during advance or retreat of the Tiskilwa ice margin and spatial variations in glacial and fluvial erosion during Tiskilwa deposition and later glacial events.

Composition

Tiskilwa till is a calcareous loam to clay loam. When unoxidized, the Tiskilwa is typically brown to grayish brown with a noticeable pink cast (7YR 5/2 to 10YR 5/2 Munsell classification); oxidized till is yellow-brown or red-brown to pinkish orange. Generally, Tiskilwa till is texturally uniform, and has a weak, angular, blocky structure in exposures. It may contain thin discontinuous lenses or layers of sorted gravel, sand, and silt. In calculating mean values of the till properties (tables 1 and 2), oxidized materials, a lower zone of different composition, and zones of sorted materials and supraglacial till were excluded.

The texture of the matrix (<2 mm) of Tiskilwa till has an average of 35 percent sand, 39 percent silt, and 26 percent clay (table 1). Standard deviations are relatively small, considering the large number of samples (850) and the extensive area of sampling. Evaluation of the county grouping of data suggests that sand content decreases and clay content increases slightly to the west; silt content remains relatively constant. The amount of gravel in these Tiskilwa samples, though variable, averages about 7 percent.

Unoxidized Tiskilwa till contains moderate amounts of illite (about 66%), and the clay mineral composition varies within a small range (table 2). The D.I. ratio averages 2.0 and the V.I. averages 2.7 (>). Chlorite in the Tiskilwa till, as well as in other red-brown tills in Illinois and Wisconsin, is probably iron-rich, weathering to vermiculite more

Table 1 County and regional mean grain-size parameters of Tiskilwa Till, Wedron Formation

	McHenry	Kane	Kendall	De Kalb	Ogle	Lee	Combined study area
Gravel (% whole)							
x	6.5	7.4	13.7	7.6	6.3	5.7	7.3
σ	5.2	5.6	6.1	4.9	3.3	3.3	5.1
n	141	266	4	348	47	31	837
Sand (s) (% <2 mm)							
x	36.6	35.2	38.5	33.9	31.1	29.0	34.6
σ	7.0	7.2	1.5	6.1	3.5	6.2	9.6
n	141	274	4	354	47	31	851
Silt (si) (% <2 mm)							
x	38.0	39.7	31.5	39.4	38.5	41.0	39.2
σ	3.9	5.0	5.5	5.8	3.3	8.8	5.2
n	141	274	4	354	47	31	851
Clay (c) (% <2 mm)							
x	25.4	25.1	30.0	26.7	30.4	30.0	26.2
σ	5.9	6.5	7.2	5.5	5.1	6.7	6.1
n	141	274	4	354	47	31	851
summary (s-si-c)	37-38-25	35-40-25	39-30-31	34-39-27	31-39-30	29-41-30	**35-39-26**

x = sample mean σ = standard deviation n = number of samples

Table 2 County and regional mineralogical parameters of the < 2μ fraction as determinated by X-ray diffraction, Tiskilwa Till Member, Wedron Formation

	McHenry	Kane	Kendall	De Kalb	Ogle	Lee	Combined Combined study area
Calcite (cps)							
x	48.5	40.0	41.0	33.0	38.4	30.0	38.0
σ	11.7	12.1	7.2	9.7	8.3	10.0	12.3
n	167	272	4	405	38	31	917
Dolomite (cps)							
x	81.0	64.4	51.3	48.2	52.2	44.0	58.9
σ	20.4	19.6	19.5	13.2	9.7	12.6	20.8
n	167	272	4	405	38	31	917
Expandables (E) %							
x	11.6	12.4	12.1	10.1	10.4	9.1	11.1
σ	3.3	2.8	2.4	2.1	1.6	2.2	2.8
n	167	274	4	405	38	30	918
Illite (I) %							
x	66.3	65. 2	65.4	67.0	66.4	67.3	66.3
σ	3.3	2.8	1.1	2.8	2.6	2.3	3.0
n	167	274	4	405	38	30	918
Chlorite (C) + kaolinite (K) %							
x	22.1	22.4	22.5	22.9	23.2	23.6	22.6
σ	1.9	2.7	2.7	2.6	3.9	2.7	2.6
n	167	274	4	405	38	30	918
D.I.							
x	2.0	2.0	1.9	2.0	1.9	1.9	2.0
σ	0.2	1.2	0.3	0.6	0.2	0.3	0.7
n	167	271	4	408	38	30	918
V.I.							
x	4.7>	4.8>	2.8>	1.0>	1.2>	1.1>	2.7>
σ	4.1	4.4	3.6	2.9	2.0	3.4	4.1
n	167	260	4	394	38	30	893
summary (E-I-C+K)	12-66-22	12-65-23	12-65-23	10-67-23	10-67-23	9-67-24	**11-66-23**

x = sample mean σ = standard deviation = number of samples cps = counts per second

Table 3 Mean Chittick carbonate data for the <74 μm fraction of selected samples, Tiskilwa Till Member, Wedron Formation

	McHenry	Kane	Kendall	De Kalb	Ogle	Lee	Combined study area
Calcite %							
x	10.8	10.4	8.4	7.7	8.4	9.0	9.9
σ	1.9	1.9	1.1	.9	1.2	2.1	
n	63	66	39	7	5	5	185
Dolomite %							
x	33.0	30.1	27.8	27.4	24.2	30.6	30.4
σ	3.4	4.8	2.2	2.4	2.4	2.9	4.3
n	63	66	39	7	5	5	185

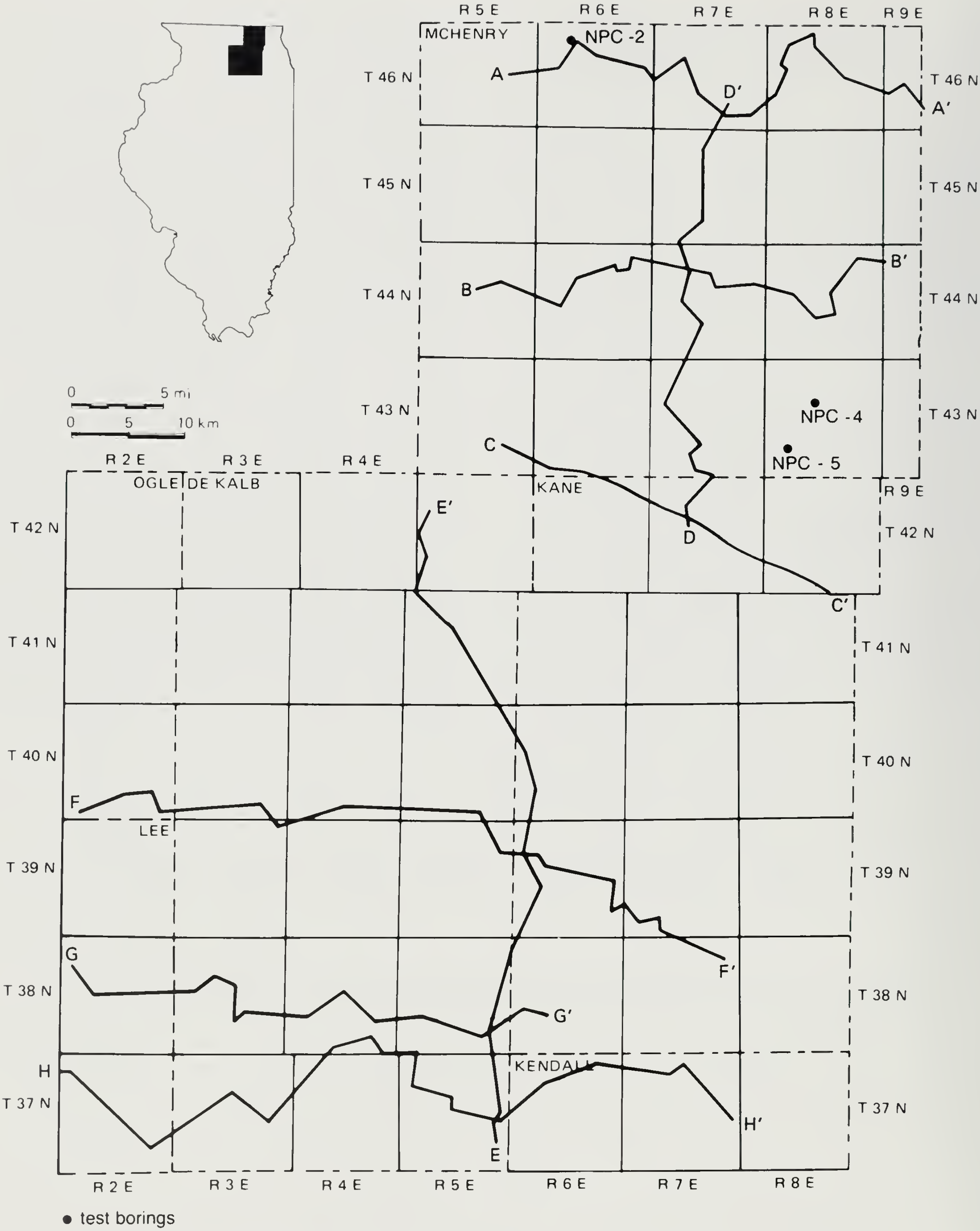


Figure 7 Location of cross sections.

rapidly than does the magnesium-rich chlorite in gray tills. The <2-μm carbonates analyzed by X-ray diffraction average 38 counts per second (cps) calcite and 59 cps dolomite and have considerably greater standard deviations than the clay mineral means. The greater variability is a result of orientation effects along cleavage planes of the carbonates. Chittick carbonate results of the <74-μm fraction (table 3) show an average of about 10 percent calcite and 30 percent dolomite.

Variability of composition

Vertical variability Most thick end and ground moraine sequences of Tiskilwa till have surprisingly small standard deviations around the mean values of compositional parameters. A boring in McHenry County (fig. 9), where the Tiskilwa is 300 feet (90 m) thick, is typical. These uniform characteristics would seem to require a uniform source area, consistent comminution processes, thorough mixing of comminuted debris, regularity in ice-flow direction, and a consistent mode of deposition (Wright et al., 1973). Also see Kempton and Hackett (1968).

Zones of variable grain size or clay mineral composition are present throughout the sequence or in a lower zone. These zones of more variable composition are neither found exclusively in one portion of the area nor in any sort of pattern across the area.

Thin seams and layers of sand, gravel, silt, and variable till within more homogeneous till are interpreted as incorporated material that was either sheared into or frozen onto the base of the glacier and subsequently deposited as melt-out till. Some of the sorted deposits, however, probably accumulated in subglacial channels.

Thicker zones of more variable grain-size material, which may occur at any position, are usually composed of sorted or partly sorted materials. Those that occur in the upper portion of the sequence are attributed to resedimentation in the ice marginal and supraglacial environments. Supraglacial till is recognized in the upper part of the Tiskilwa Till throughout the outcrop area by its material type and morphology. Where differentiated, it ranges in thickness from less than 1 foot (.3 m) to 60 feet (18 m) and is characterized by till of variable grain size, commonly interbedded with thin layers or lenses of sorted gravel, sand, silt, or clay. Because these deposits are often coarser and less massive than the underlying basal till, they are usually leached and oxidized to greater depths than is basal till in the same landscape position. Supraglacial till was delineated in several borings, but was not mapped for this study; more detailed field study is required.

In a few locations, stratified materials probably related to the Tiskilwa Till are present at the base of the Tiskilwa. These are interpreted to be incorporated older deposits, subglacial or englacial channel deposits, or proglacial outwash; however, it was not possible to determine the lateral extent or origin of these zones because of the lack of adequate subsurface control.

A lower zone of different till character has also been observed locally in the Tiskilwa Till. The lower zone usually is finer grained than the main body of the Tiskilwa, containing more illite in the clay fraction, and in some places, more sand. Unaltered samples of this lower zone have either a browner or grayer color than the typical Tiskilwa. This zone may be gradational or may have an abrupt contact with the overlying, more uniform till of typical Tiskilwa composition.

The zone in the lower part of the Tiskilwa Till is interpreted as resulting from local incorporation of older glacial materials or bedrock into the base of the Tiskilwa ice. Comparison of two deep test borings, located approximately 3

LEGEND FOR FOLLOWING CROSS SECTIONS

Till
Outwash, sand and gravel
Lacustrine, bedded silt and clay
Ice-contact; unsorted sand, gravel, silt and clay; may be stratified, variable
Peat or organic salt
Buried soil, leached or oxidized zone
55500 Well log or boring; number refers to identification number

County abbreviation followed by a number and letter:

McH - McHenry County
Kne - Kane County
Ken - Kendall County
DeK - De Kalb County
Lee - Lee County
Ogl - Ogle County
} highway, bridge or foundation borings

SCS - Soil Conservation Service test hole
S - test borings drilled specifically for this study
JB - test borings drilled specifically for Kendall County study
LW - Landfill Study borings

Unit abbreviations

ri - Richland Loess
h - Henry Formation, undifferentiated
ec - Equality Formation, Carmi Member
c - Cahokia Alluvium
py - Peyton Colluvium
wh - Wedron Formation, Haeger Till Member
wy - Wedron Formation, Yorkville Till Member
wy-m - Wedron Formation, Yorkville Till Member-mixed composition
wm - Wedron Formation, Malden Till Member
wm-m - Wedron Formation, Malden Till Member-mixed composition
wt - Wedron Formation, Tuskilwa Till Member
ot - older till and outwash, undifferentiated
ou - outwash, undifferentiated
ro - Robein Silt
-m - unit mixed with older units
-o - outwash, related to till unit
-l - lacustrine materials related to till unit
-s - supraglacial till
br - bedrock

Boring identification

NPC - Northeastern Illinois Planning Commission test hole
ISGS - Illinois State Geological Survey test hole
NWT - North-west Tollway test hole
EWT - East-west Tollway test hole
12211 - sample set number for water well or test boring

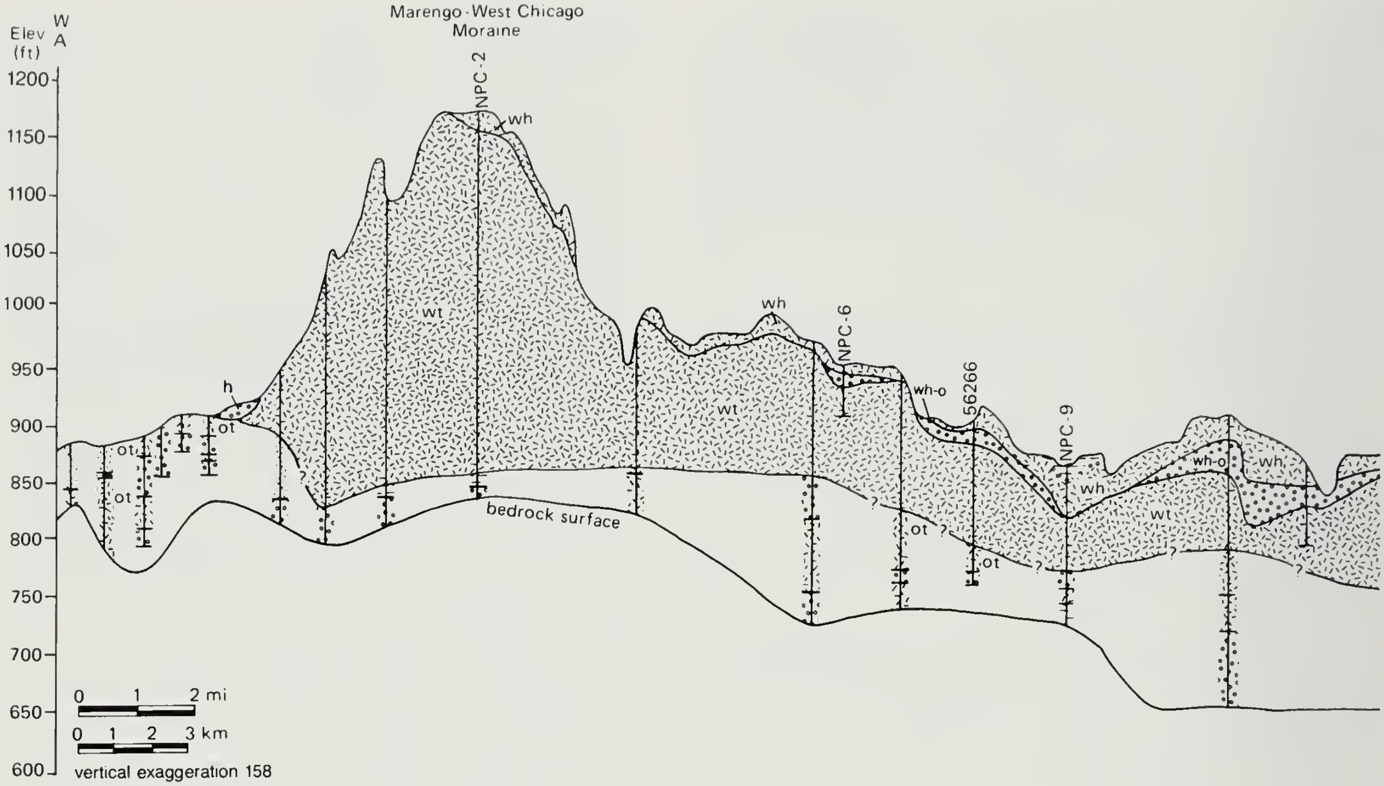


Figure 8a Cross section A-A′.

miles (4.8 km) apart in a direction perpendicular to ice flow, illustrates lithologic variations in the lower part of the Tiskilwa (fig. 10). In one boring (NPC-5), Robein Silt occurs beneath the Tiskilwa and the lower zone is not present; typical Tiskilwa till occurs at the base of the unit. This sequence suggests that no erosion occurred at the site and that apparently little or no erosion occurred immediately up-ice from the site. The other boring contains a thick lower zone underlain by thin, gravelly sand. In this case the composition of the lower zone is uniform and the grain size is also relatively uniform, with a slight coarsening upward trend (about 24% sand in the lower samples and about 30% in the upper samples). Local erosion probably has been greater in this area and along the ice flow path, and incorporation and mixing of subjacent materials probably diluted the typical Tiskilwa composition (Wickham and Johnson, 1981). In places where the lower zone is browner than typical Tiskilwa, appreciable quantities of carbonaceous material from the Robein Silt probably have been entrained; where it is grayer, the eroded material is probably bedrock or gray till.

In many areas, the lower zone is not distinct and zones of transitional composition are seen where the Tiskilwa overlies and incorporates older drift. In these areas, as exemplified on figure 14, it is difficult to pick a lower boundary for the Tiskilwa Till without obtaining detailed analytical data on samples or examining continuous cores.

The recognition that the Tiskilwa includes a lower zone having a composition different from that of the typical Tiskilwa is important with respect to the definition and interpretation of the unit. Such zones differing in composition from the main body of till are termed *mixed-composition zones* in this paper. These zones may originate by local, basal incorporation, such as in the Tiskilwa, or may originate by mixing of different till compositions in the supraglacial and ice marginal environments, as is common in the younger till units in the area.

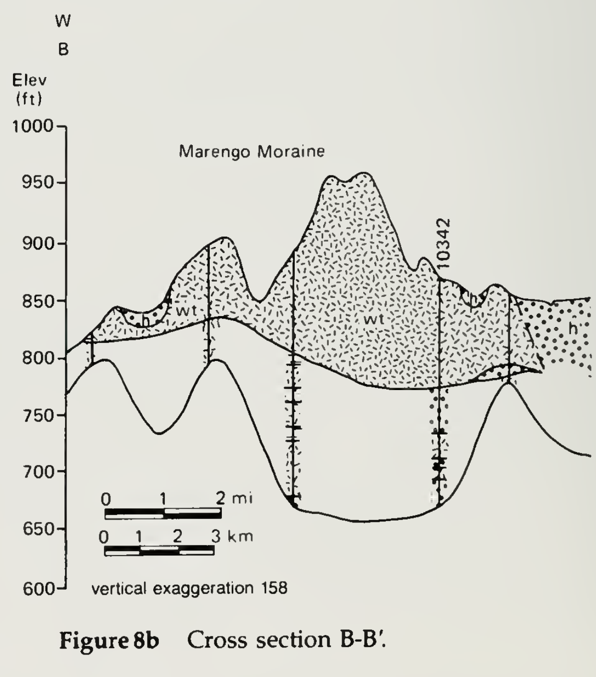
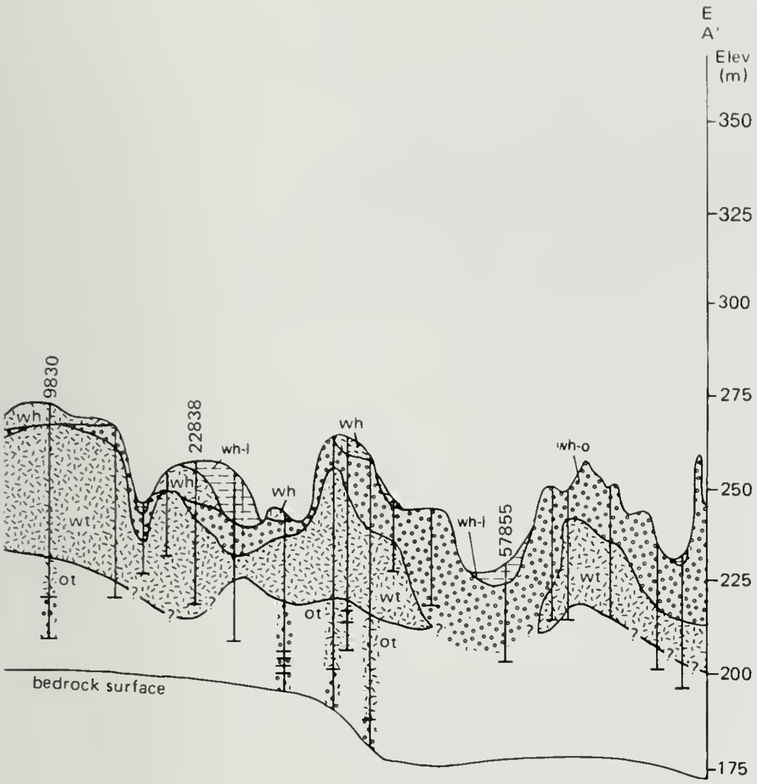


Figure 8b Cross section B-B′.



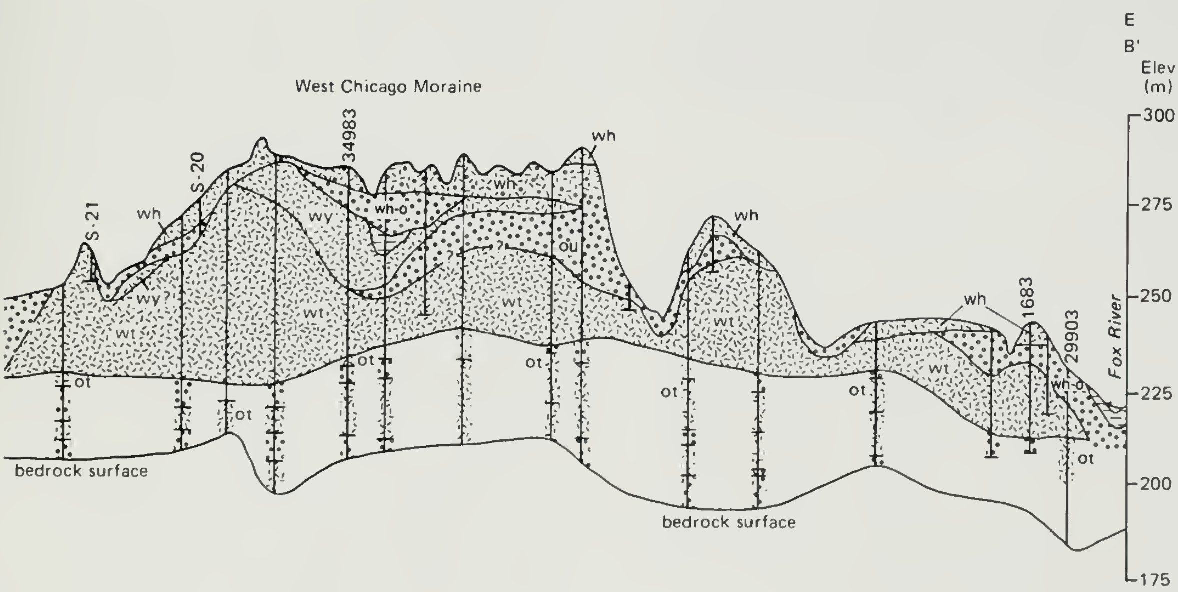
Areal variability The composition of the Tiskilwa Till does not change significantly throughout the study area. Slight lateral trends are observed; however, these trends may not be significant, given the present distribution pattern of available borings and samples. For example: borings drilled for the Northeast Illinois Planning Commission were sampled every 5 feet (1.5 m), and none are located in the Bloomington Morainic System (De Kalb Co.); Illinois State Geological Survey test borings were sampled from some arbitrary depth and then about every 10 to 20 feet (3 to 6 m), and are located mainly in southern De Kalb and Kane Counties; water wells are scattered throughout the area, but samples are available from only a few of them; and engineering borings usually penetrate only the upper portion of thick till units and are concentrated along major highways and surrounding cities. Therefore, where shallow borings are plentiful, most of the samples are from the upper portion of till, and in borings where deeper units were of major interest, most samples are from the basal portions of the till.

The county groups of data for Tiskilwa till (tables 1 and 2) show a slight trend westward toward a more clayey matrix, slightly more illite than normal, and a Vermiculite Index ranging from 4.8 (>) to about 1.0 (>). This trend may reflect increased sampling of the lower zone in the western part of the area, or may indicate an increasing thickness of the lower zone, the result of growth of the lower zone of mixed-composition to the west. If the latter interpretation is correct, the entire till unit may approach the composition of the lower zone as the distance of transport increases and more local source materials are entrained. These changes would reflect the basal ice conditions of erosion and entrainment in the marginal zone (Wickham and Johnson, 1981).

Topography of the Tiskilwa surface

The surface of the Tiskilwa Till Member (fig. 11) has the greatest relief and highest elevations in the Bloomington Morainic System and Marengo Moraine. The highest portion of the Tiskilwa surface is in northwestern McHenry County where elevations are greater than 1100 feet (335 m). As previously noted, the highest elevations on the sub-Tiskilwa surface and the bedrock surface, as well as the thickest sequence of Tiskilwa Till, also occur in this area (figs. 4, 5, and 6).

Individual ridges outlining the four Bloomington moraines are not easily distinguished on figure 11 because



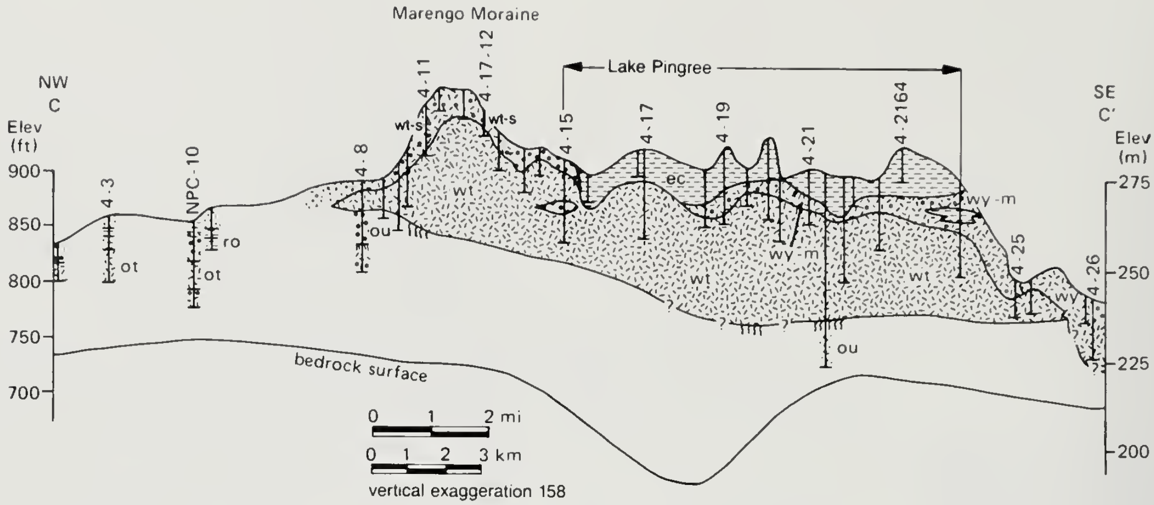


Figure 8c Cross section C-C′.

of the large contour interval (50 ft; 15 m) but are evident on some cross sections (figs. 8e,f,g). The Bloomington forms a broad high, with portions reaching an elevation of 950 feet (290 m). The single ridge of the Marengo Moraine, however, is distinct and relatively higher (50 to 100 ft; 15 to 30 m) than the Bloomington System. A southward extension of the Marengo Moraine (elevation 900 feet, 275 m) can be observed on the Tiskilwa surface map (fig. 11), and also on the Tiskilwa thickness map (fig. 6). The southward extension has been buried by deposits of succeeding glacial advances (mainly Malden Till).

Another buried ridge (elevation 900 and 950 feet, 275 and 290 m) in central McHenry County also generally corresponds to thick Tiskilwa Till (fig. 6). This "high" curves from north-south to east-west and forms the core of the West Chicago Moraine and portions of the Gilberts Moraine. Here Tiskilwa deposits are buried and their relief accentuated by the younger Yorkville and Haeger Till Members of the Wedron Formation (fig. 8b). Inliers of Tiskilwa occur in isolated locations throughout areas covered by the younger drift.

The lowest portion of the surface of the Tiskilwa Till occurs in the southeast corner of the study area (fig. 11). The general slope of the surface reflects the bedrock and sub-Tiskilwa surfaces (figs. 4 and 5). Low areas on the Tiskilwa surface appear to be the result of erosion by rivers draining westward through the moraines or eastward toward the Fox River, and by the Tiskilwa and younger glacial advances, rather than by nondeposition of Tiskilwa till.

Supraglacial and basal till, and fluvial and lacustrine deposits are found on the surface of the Tiskilwa. In some areas these materials have been modified by periglacial processes. Pingo scars near De Kalb (Flemal et al., 1973) that may contain as much as 20 feet (6 m) of lacustrine deposits were formed between the time of deposition of the Tiskilwa Till and ice margin retreat and advance of the Malden ice sheet to the position of the Arlington Moraine.

YOUNGER TILL UNITS

Younger till units in the study area include the Malden, Yorkville, and Haeger Till Members of the Wedron Formation. A generalized surficial deposits map (fig. 12) delineates for the first time subunits of mixed composition within these members. These subunits have properties interpreted as resulting from entrainment of Tiskilwa and older tills or bedrock and mixing of this locally derived material with debris entrained up-ice by succeeding glacial advances. This process of incorporation of older drift has been termed "redeposition" by Gillberg (1977). The map (fig. 12) does not show deposits of small areal extent that are delineated on some borings in the cross sections (figs. 8a-h).

Malden Till Member

The Malden Till Member, generally 5 to 30 feet (1.5 to 9 m) thick, contains basal till, ice-contact deposits of supraglacial till associated with abundant bodies of silt and sand, and till of mixed composition that is variable in character. Malden is the surficial till unit in a large portion of the Princeton Sublobe (in the southern part of the study area) where it overlies the Tiskilwa Till Member. It is not recognized in the Harvard Sublobe (northern part of area) in this report (fig. 12).

Basal till of the Malden has a loam texture; it is dark gray brown (2.5Y 4/2) when unoxidized and oxidizes to an olive brown (2.5Y 4/4). Its clay mineral composition is similar to that of till in the younger Yorkville Till Member (table 4) and is distinguished from it primarily on the basis of stratigraphic position and texture—Malden generally is coarser grained than Yorkville till. The till is coarser (about 10% more sand) than Malden till in the western part of the Princeton Sublobe area where the unit was defined (Willman and Frye, 1970). It is similar in texture, however, to till in units 1 and 2 of the Malden Till Member at the Wedron Section (Johnson et al., 1985) located south of the study area. Further regional study will be necessary to determine

if the different textural types within the Malden are lateral facies, different till subunits, or possibly some combination of both. The regional clay mineral composition of the Malden is relatively uniform except where it has been modified by entrainment of older drift or by weathering.

The region mapped as Malden-mixed composition (fig. 12) contains till and other drift that generally contains less illite and has a more variable Vermiculite Index than typical Malden till. The till contains an appreciable amount of sand, and commonly contains more clay than does typical Malden till; its textures are more variable, ranging from clay loam to loam. The illite content of the clay fraction ranges from 65 to 73 percent and the V.I. from 6(<) to 2(>). Locally, however, the mixed-composition material is more uniform; for example, in the southern portion of the Elburn Complex, values of about 70 percent illite and a V.I. of 4(<) are common. The mixed-composition drift makes up the entire unit in some areas, but in others it is discontinuous, occurring at the base and grading upward to till with a typical Malden composition. The mixed-composition material is most common in end moraines and in the Elburn Complex (figs. 1 and 12). It is interpreted to be Malden till that contains variable amounts of material eroded locally from the Tiskilwa and older drift units.

The ice-contact deposits consist of poorly sorted, stratified sand and gravel that commonly contains layers and lenses of supraglacial till and well sorted sand, gravel, silt, and clay. These deposits, mapped as ice contact-mixed composition (fig. 12), make up a complex of kames, eskers, and other ice-disintegration features in the southern part of the Elburn Complex (fig. 1). The deposits and morphology indicate that the ice sheet stagnated at its margin in this area.

Yorkville Till Member

Yorkville Till is a silty clay to clay loam till with a gray to brownish gray color, which oxidizes to an olive brown. It overlies the Malden Till Member in the Princeton Sublobe and the Tiskilwa Till Member in the Harvard Sublobe. In addition to till, it contains abundant stratified ice-contact deposits of sand and gravel, and it is associated with extensive lacustrine deposits, many of which are mapped as Equality Formation (fig. 12).

Massive, fine-grained, silty clay till forms the basal portion of the member (called the basal till facies of the Yorkville by Kemmis, 1978). The matrix texture in this area is slightly coarser grained (15% sand, 42% silt, and 43% clay) than is described as typical (12% sand, 38% silt, and 50% clay) by Willman and Frye (1970) and observed just east of the study area (8% sand, 49% silt, and 43% clay) by Kemmis (1978); but it is similar to the texture of the lower part of the Yorkville till (13% sand, 43% silt, and 44% clay) described by Killey (1982). Textural variations probably reflect regional variations, although some may be caused by different depositional processes. Basal till thickness ranges from 5 to 50 feet (1.5 to 15 m).

A texturally variable clay loam till (mostly supraglacial till) overlies the silty clay basal till; it is typically sandier and less massive than the underlying basal till and commonly contains layers and lenses of sorted sand, silt, and

Table 4 Mean grain-size and mineralogical parameters for till members

		Matrix grain size (< 2mm)			Carbonates (< 2μm)		Clay mineral composition (< 2μm)			Clay mineral indices	
Till unit		% Sand	% Silt	% Clay	Calcite (cps)	Dolomite (cps)	% Expandable clay minerals	% Illite	% Kaolinite > chlorite	D.I.	V.I.
Haeger*	$\bar{x}$	45	39	16	33	61	21*	62*	17*	2.7*	8.4>*
	σ	17.5	12.0	9.5	13	24	16.2	8.4	7.2	1.2	5.7
	n	32	32	32	35	35	35	35	35	35	35
Yorkville	$\bar{x}$	15	42	43	26	50	4	77	19	2.6	13<
	σ	9.0	8.5	11.6	9.5	13.2	3.5	1.8	1.9	0.3	7.4
	n	84	84	84	86	86	94	94	94	94	94
Malden	$\bar{x}$	32	46	22	24	41	5	76	19	2.6	13<
	σ	6.4	4.9	5.4	8.3	10.3	1.5	2.4	2.6	.5	5.0
	n	28	28	28	33	33	33	33	33	33	33
Tiskilwa	$\bar{x}$	35	39	26	38	59	11	66	23	2.0	2.7>
	σ	9.6	5.2	6.1	12.3	20.8	2.8	3.0	2.6	1.7	4.1
	n	850	850	850	917	917	918	918	918	915	893

*All till is oxidized; value represents data for altered material

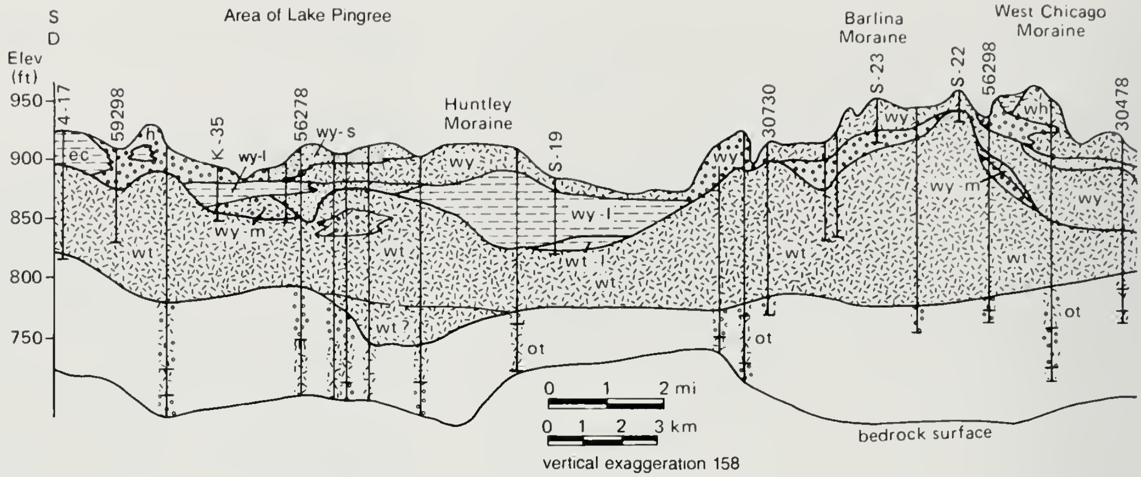


Figure 8d Cross section D-D′.

clay. This material (called ablation till facies of the Yorkville by Kemmis, 1978) is generally not more than 10 feet (3 m) thick, but locally may constitute the entire thickness of Yorkville Till—as much as 30 feet (9 m).

Bedded silt, clay, and sand were deposited in proglacial Lake Pingree (Leighton et al., 1931). These deposits, which can be as much as 35 feet (10.5 m) thick, locally are overlain by till of the Yorkville (fig. 8d). They accumulated in a low area bounded by Marengo Moraine on the west, Malden drift and possibly stagnant ice on the south, and the Yorkville ice-margin to the east and north.

Ice-contact deposits are differentiated from the supraglacial till; they are stratified, and they contain more sorted clay, silt, and sand and gravel than does supraglacial till. Where the material is mostly bedded silt and clay, it is mapped as Equality Formation or as part of the ice-contact mixed-composition material (figs. 12 and 8c). In many places the supraglacial till and ice-contact deposits are recognizable from their morphologic expression. Hummocky stagnation features—disintegration ridges and mounds, ice-walled lake plains, and kettle holes—predominate. The main zone of ice-contact material related to the Yorkville Till Member occurs within the area of Lake Pingree deposits and is characterized by ablation ridges, mounds, and extensive ice-walled lake depressions and complex sediment associations (fig. 8d).

Two mineralogic compositions are recognized within the Yorkville Till Member—typical composition and a mixed

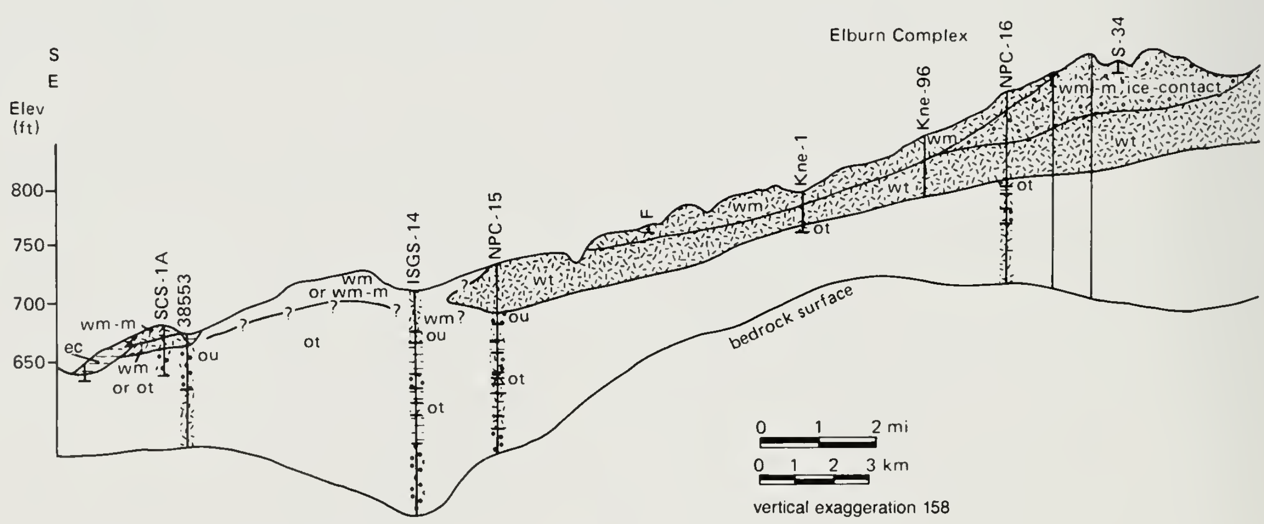
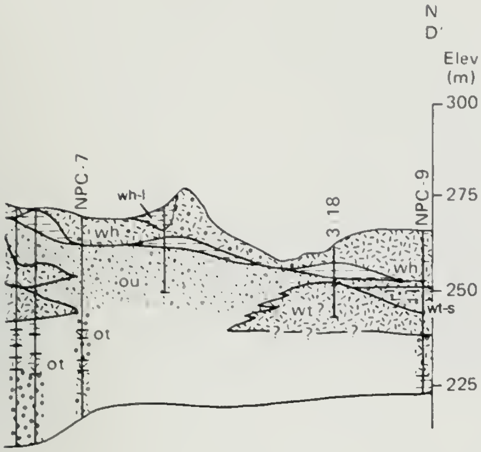


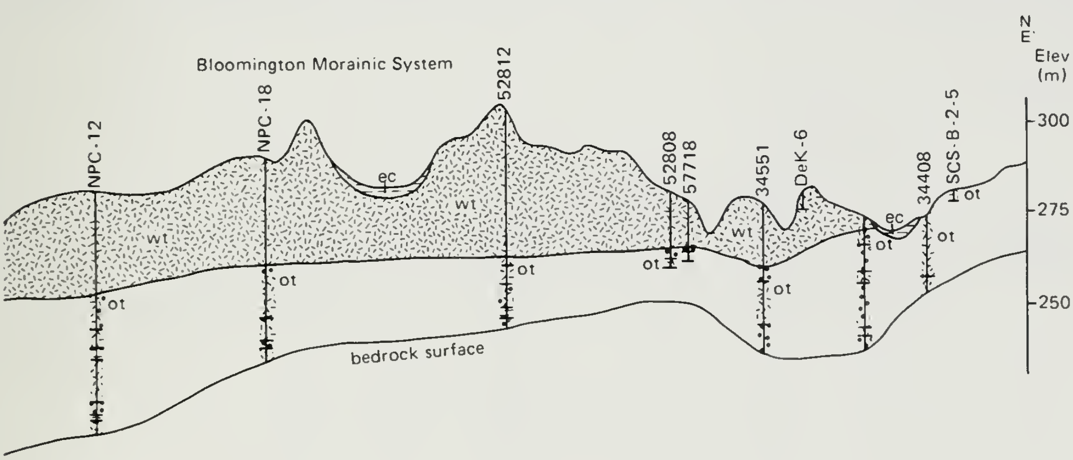
Figure 8e Cross section E-E′.



composition. These compositions do not correspond to specific material types. The typical composition is characterized by abundant illite (about 77%) and a Vermiculite Index that averages 20(<) (table 4). Killey (1982) delineated two mineral zones in the Yorkville Till Member in its type region to the south. The lower Yorkville averages 81 percent illite and has a V.I. of 33(<); an upper zone, called Dwight till, averages 76 percent illite and has a V.I. of 20(<). Most of the Yorkville Till in the study area is similar in clay mineral composition to Dwight till, although materials equivalent in composition to lower Yorkville may be present.

The second clay mineral composition recognized within the Yorkville Till Member, the mixed composition, represents a mixture of the typical Yorkville with components of older till units. The clay mineral composition of the Yorkville mixed-composition materials is identical to that of the Malden mixed-composition materials; their origin is inferred to be similar. The Yorkville mixed-composition materials are differentiated from the Malden mixed-composition materials primarily on the basis of areal occurrence and locally on stratigraphic position. Mixed-composition drift of the Yorkville Till Member rarely is found in massive till except where it is at the very base of the unit; typically it is seen in the more variable grain-sized material—clay loam till, ice-contact materials, and some lake sediments—that range from 20 to 44 percent sand, 50 to 74 percent silt and 12 to 36 percent clay. Where till-like, the Yorkville mixed-composition materials are finer grained than the Malden mixed-composition materials, but both are quite variable. Many of the surficial lake sediments in the study area are so altered that it is impossible to relate their mineralogy to either the mixed or typical till compositions, and they are mapped as Equality Formation, undifferentiated (fig 12).

A significant portion of the Yorkville mixed-composition materials is pinkish gray to brown, with a clay mineral composition intermediate between that of Tiskilwa till and typical Yorkville (or Malden) till; this is particularly true in the Gilberts Moraine (fig. 1). Previous mapping has included the deposits in this area in the Malden Till Member (Willman and Frye, 1970) or the Tiskilwa Till Member (Lineback et al., 1979b). We include them in the Yorkville Till Member because (1) they are associated with and overlie proglacial Lake Pingree deposits that we interpret to be related to the Yorkville ice margin advance; and (2) the mixed-composition character of the clay minerals indicates that the deposits contain both a Tiskilwa component and a younger (Malden or Yorkville) component. The latter relationship suggests that these deposits are probably younger than the Tiskilwa, but could be related to the Malden or Yorkville glacial events.



Haeger Till Member

The Haeger Till Member contains sandy loam till that commonly is thin and underlain by and interstratified with outwash, lacustrine, and ice-contact deposits. When outwash and lacustrine deposits occur at the surface, they usually are classified as the Henry and Equality Formations, respectively (Willman and Frye, 1970). In this study, where such deposits are closely associated and genetically related to the Haeger Till, they are classified and mapped as Haeger-related deposits (fig. 12). The Haeger Till Member overlies the Yorkville Till Member (fig. 8d) or the Tiskilwa Till Member (fig. 8a) in the Harvard Sublobe. It is overlain by the Wadsworth Till Member east of the study area.

Haeger till averages 10 to 15 feet (3 to 4.5 m) thick, but in many areas it is less than 5 feet (1.5 m) thick or completely absent. The till tends to be thicker at its terminus and on uplands. It is the coarsest till in the area (table 4) and typically is oxidized yellow brown (10YR 5/4 to 5/6), structureless, and friable. The till is highly variable both texturally and mineralogically (table 4); the largest standard deviations are in the sand, dolomite (cps), and expandable clay mineral parameters. Expandable clay mineral percentages are variable because only oxidized (altered) samples were available for analysis.

The composition and color of the Haeger varies locally because the till acquires characteristics from the underlying till or outwash (mainly Tiskilwa till and pro-Haeger outwash). In addition to entrainment and mixing of older drift materials into Haeger till, large blocks or inclusions of older tills (Tiskilwa and Yorkville) can be observed within the till in Mc Henry County. These same characteristics have been observed in southeastern Wisconsin (Johnson, 1976; Fricke and Johnson, 1983), where fine materials and reddish colors in the Haeger were attributed to incorporation of Tiskilwa till, and an extreme sandy and gravelly characteristic was attributed to incorporation of outwash.

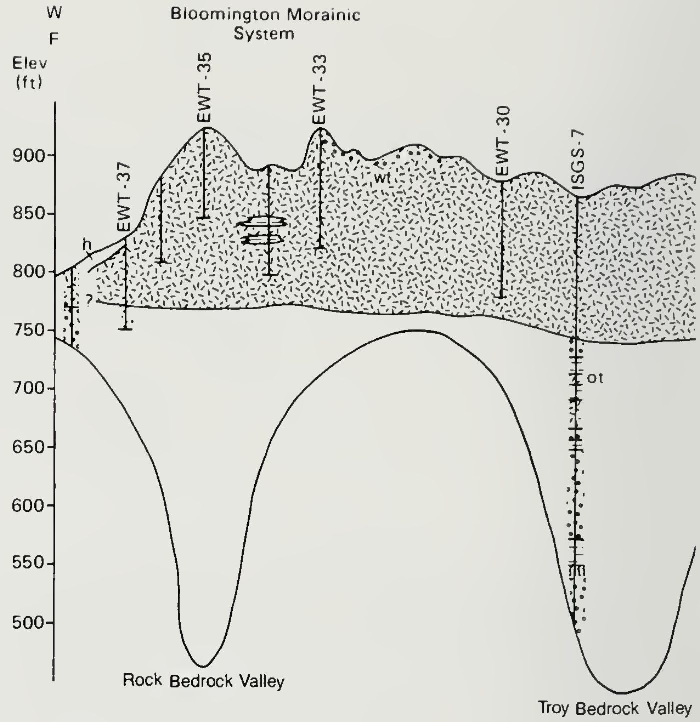


Figure 8f Cross section F-F′.

In most of McHenry County the Haeger Till terminus is marked by the West Chicago Moraine (fig. 1); the moraine in this area has recently been redefined as the Woodstock Moraine, (Hansel et al., 1985), which comprises hummocky stagnation features. Near Woodstock (T44N, R7E), the

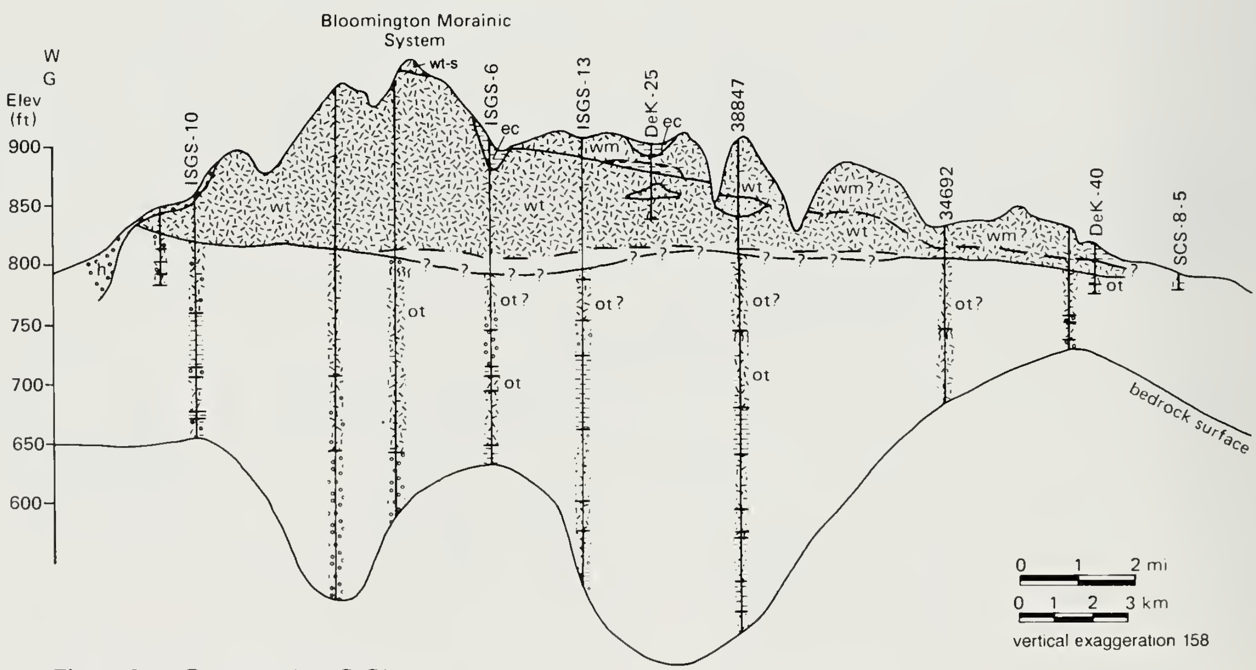
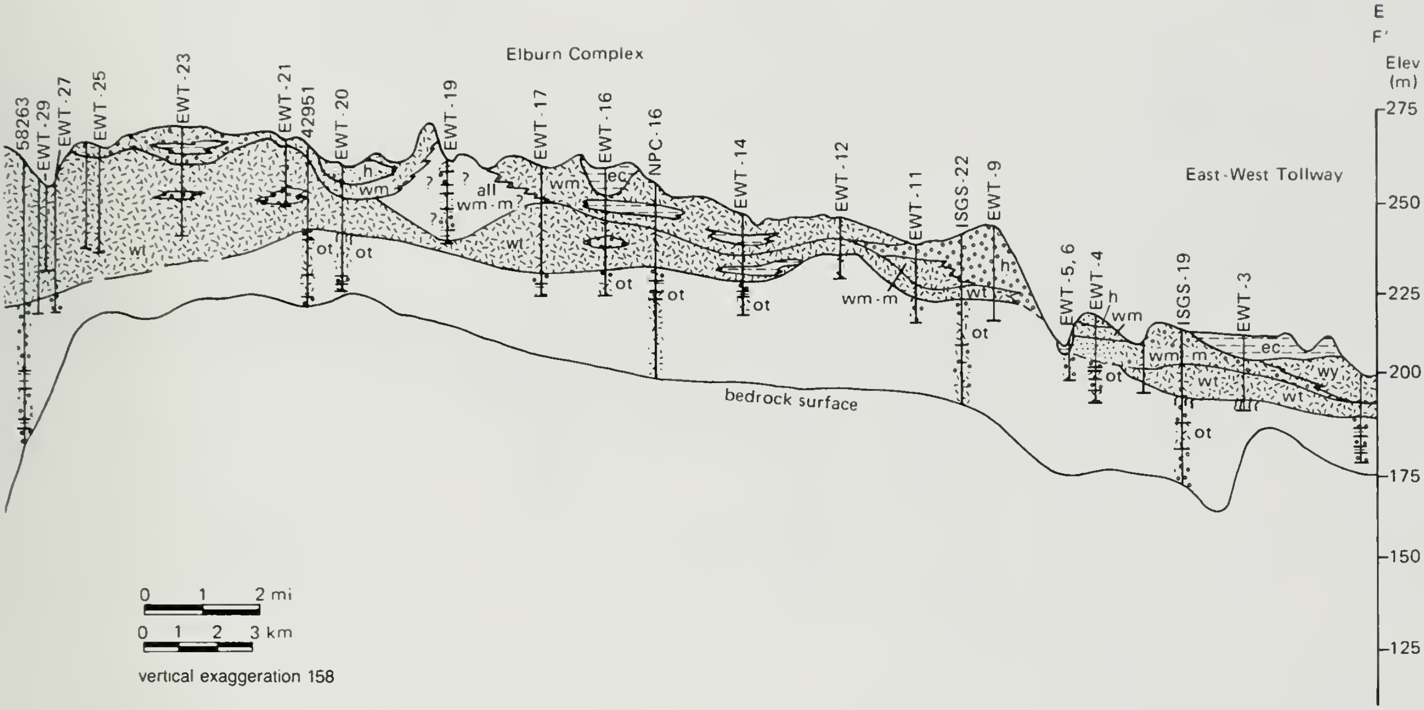
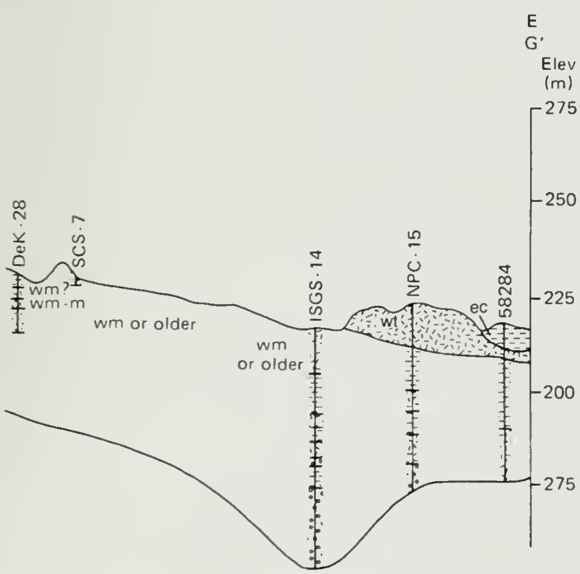


Figure 8g Cross section G-G′.



stratigraphy is complex and a large portion of the moraine is palimpsest (fig. 8d). Thin till of the Haeger is draped over proglacial Haeger outwash and thick Tiskilwa till. In some areas this proglacial outwash lies in lows in the undulating Tiskilwa surface, and Tiskilwa till is exposed locally in windows. Some Haeger till and related deposits may extend beyond the morainic boundary in this area.



A large gap in the West Chicago Moraine just south of Woodstock contains kamic ice-contact deposits related to the Haeger till. Additional areas of Haeger-related ice-contact deposits are found throughout McHenry County, generally in northeast-trending valleys and ridges (Wonder Lake region and northern border of McHenry and Lake Counties) that are approximately parallel to the direction of ice flow. This area is an extremely complex association of lacustrine silts and clays, flow tills, outwash, and melt-out till. The elongate lowlands probably originated as subglacial (tunnel) valleys and have been modified during subsequent stagnant ice deglaciation.

Summary

The three till members younger than the Tiskilwa Till Member (the Malden, Yorkville, and Haeger) have several characteristics in common.

- Till in all three units is thin, generally less than 30 feet (9 m) thick. Although these younger tills appear at the surface of several of the major morainic features, the high elevation of the moraines largely reflects the buried topography of the Tiskilwa Till.
- The surface morphology of these three till units is similar: all have relatively large areas of hummocky terrain of ice-contact origin. Stagnant ice sedimentation characterized deglaciation over much of this area.
- The basal till of each of the three younger till units has a characteristic texture and composition, but all contain compositions and textures that vary from the typical composition of each unit. These variations are interpreted to be the result of entrainment of Tiskilwa or older drift into the basal load of the ice sheet. This more locally entrained debris is either deposited more or less intact as an inclusion or is

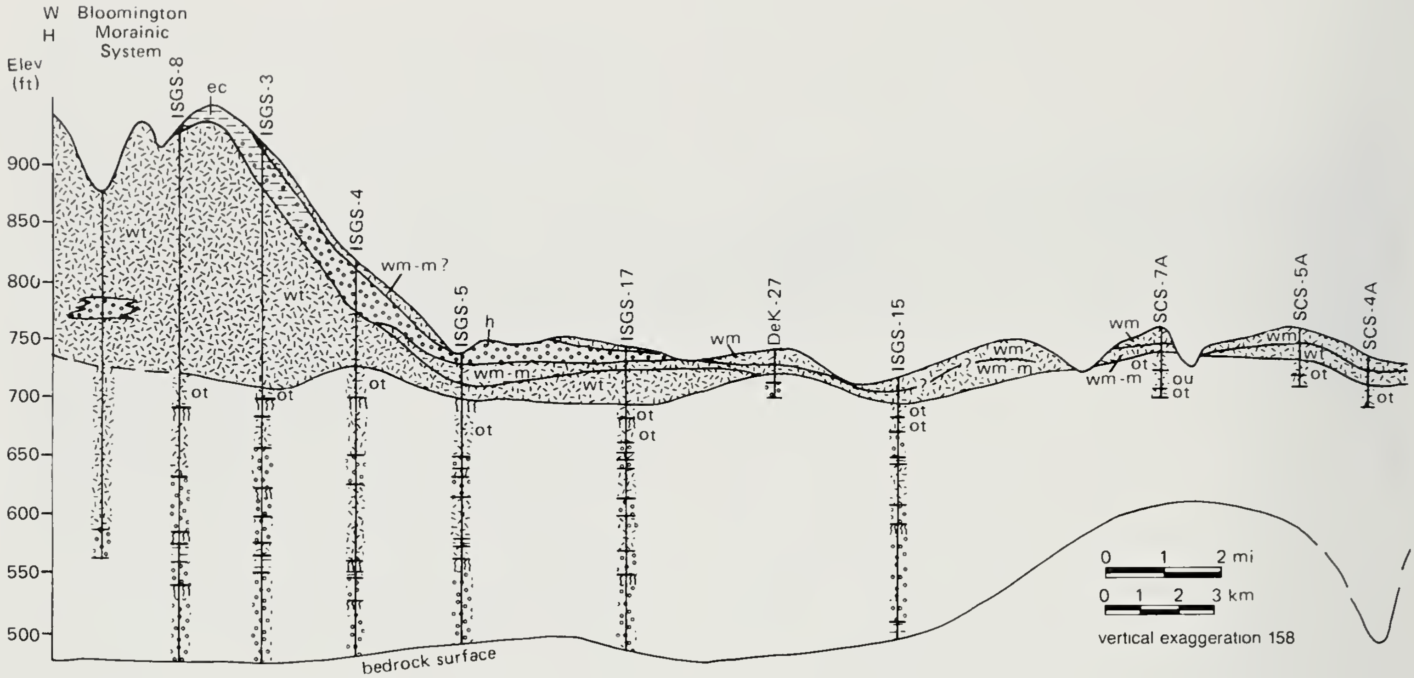


Figure 8h Cross section H-H'.

comminuted and mixed with debris entrained up-ice during transport and basal till deposition or through processes of resedimentation in the supraglacial and proglacial environments. Such mixed-composition material in these three units is often pinkish gray to brown as a result of entrainment or incorporation of Tiskilwa till.

DISCUSSION

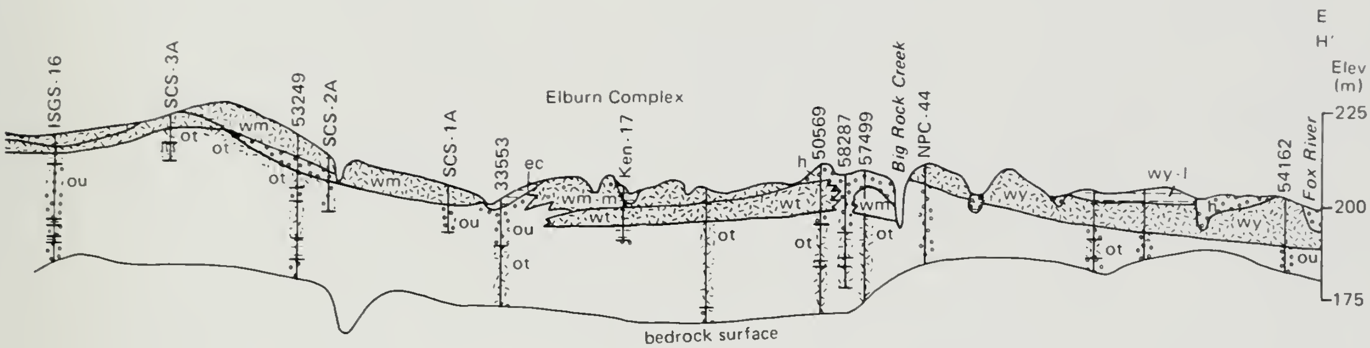
Tiskilwa Till composition

Factors that affect till composition include source material lithology; processes of entrainment; mode, position and distance of glacial transport; processes of comminution; mode and position of deposition; and postdepositional changes (Boulton, 1970a; Dreimanis and Vagners, 1969; Dreimanis, 1976; May and Dreimanis, 1978; Lawson, 1979).

The characteristics of Tiskilwa Till—red brown, moderate illite content and loamy texture—differ from those of the gray, more illitic Malden and Yorkville tills in the area. We feel that changes in source material lithology account largely for this contrast. The Tiskilwa had multiple source lithologies and/or source areas. The distinctive red color and clay mineral composition reflect the bedrock in and around the Lake Superior Basin or red drift derived from that bedrock, whereas the relatively large carbonate content and illitic clay minerals reflect more locally derived bedrock and drift in the Lake Michigan Basin and its southern margins. It is not possible to say which source lithology was dominant; however, it is clear that incorporation of locally derived materials was not adequate to mask the influence of red debris initially derived from the Lake Superior region.

Wickham and Johnson (1981) suggested that possibly because of temporal and spatial variations in basal thermal regime, erosion and entrainment probably occurred in different regions at different times during the Woodfordian. Thus, initially, material eroded in the Lake Superior region significantly influenced till composition (Tiskilwa till), but later the Lake Michigan basin was the dominant source area (for Malden, Yorkville, and Haeger tills).

Alternatively, Mickelson (1985, personal communication) has suggested that the characteristic red color and clay mineral composition of the Tiskilwa may have been derived from the erosion of red tills and lake clays that may have existed in and around the Lake Michigan Basin prior to Woodfordian glaciation. Assuming that the surficial geology of the preceding interglacial period was similar to that of the current interglacial period, the latter can be used as a partial test of this idea. Red tills occur along the northern two-thirds of the Lake Michigan coast in Wisconsin (Acomb et al., 1982) and in Michigan (Melhorn, 1954; Eschman, 1985); moreover, red tills and clays occur in bottom sediments of Lake Michigan (Wickham et al., 1978; Lineback et al., 1979a). All of the sediments in the basin are discontinuous and have an irregular thickness (Wickham et al., 1978). Red clays up to 15 meters thick are found in the deeper lake basins, but are absent from about half the lake area. The average thickness probably is less than 5 meters. The red clays are overlain by gray clays, more extensive but thinner than the red clays (Wickham et al., 1978). The gray clays are thickest (commonly 5 to 10 m) along the east side of the lake basin. If lake sediment in Lake Michigan were the dominant source of the Tiskilwa and the distribution and character of pre-Tiskilwa lake sediment were somewhat similar to that of today, it would appear that the Tiskilwa or Tiskilwa-correlative units deposited by the eastern portion of the Lake Michigan Lobe should be grayer than the



Tiskilwa deposited by the western portion of the Lake Michigan Lobe area. This is not the case; reddish tills that are similar to, and considered to be correlative with, the Tiskilwa occur both in eastern Illinois (Johnson et al., 1971) and in western Indiana (Bleuer et al., 1983). It may be, however, that red tills were more important than red clays in determining the color and composition of the Tiskilwa. Thus, it is not clear which of the two interpretations—or more likely, what combination of both—correctly explains the source of the color and clay minerals in the Tiskilwa.

Basal till in the Tiskilwa, as in many tills in the mid-continent region, has a relatively uniform composition. The processes involved in the evolution of a uniform till over a wide area are not known. Previous workers have suggested transport and comminution for long distances (Karrow, 1976), erosion and entrainment from an identical series of source areas (Parkhurst, 1975), or the lodgement depositional process (Eyles and Menzies, 1983) as probable causes for uniformity. Kemmis (1981) has proposed the regelation process as a mechanism for homogenization of till during transport.

If a major component of the Tiskilwa was derived from the Lake Superior region, as suggested by Wickham and Johnson (1981), glacial transport would have been approximately 700 miles (1120 km). Material derived from the Lake Michigan Basin, however, would have been transported a a much shorter distance, in some instances less than 50 miles (80 km), and it also is uniformly mixed with debris entrained farther up-ice. Thus, if homogenization occurs primarily during transport, transport of 50 miles or probably less appears adequate.

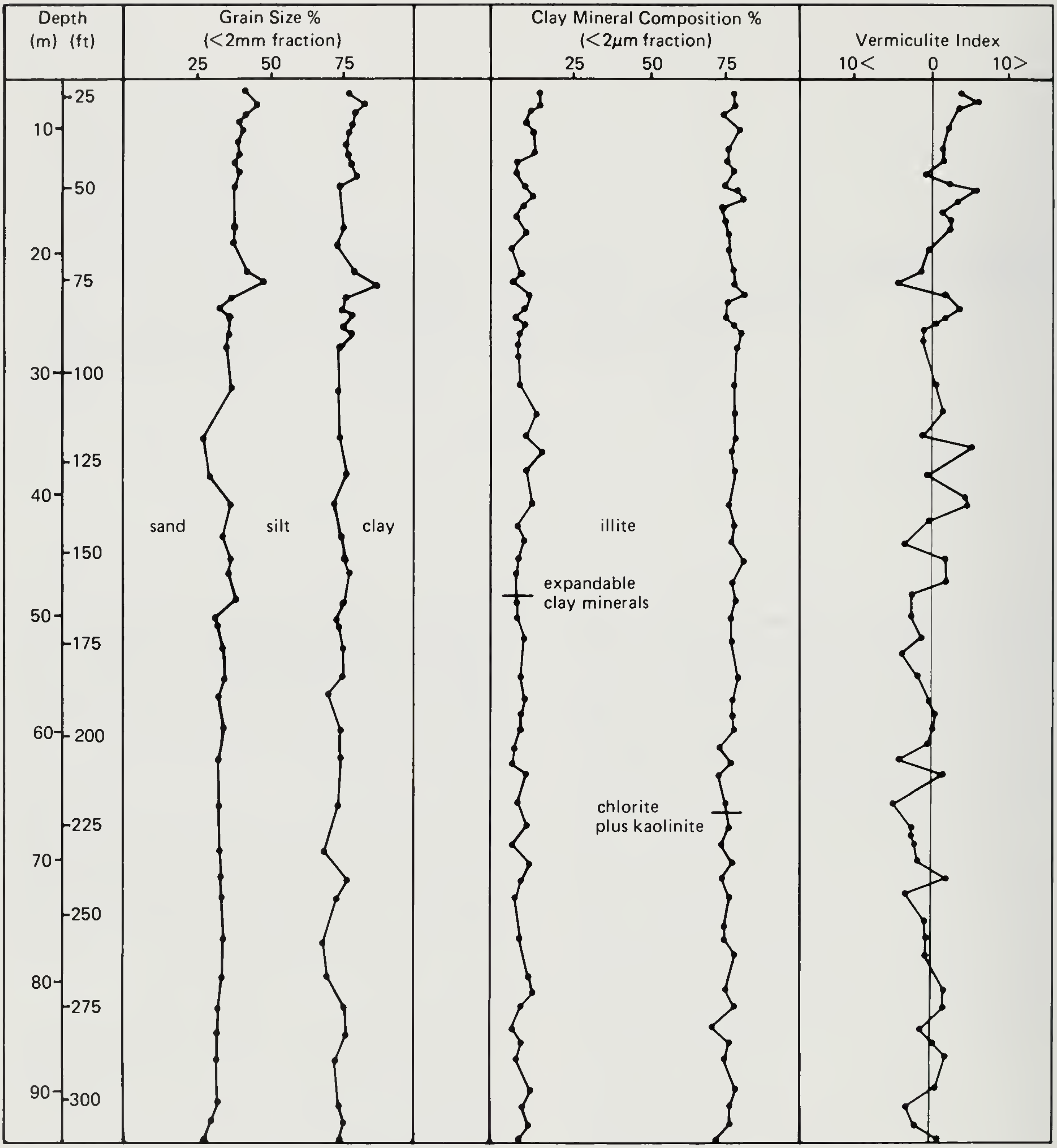
Thick, uniform till of the Tiskilwa is considered to be basal till. Studies at the Wedron Section, located south of the study area, suggest that the Tiskilwa there was deposited by lodgement (Johnson et al., 1985) and much of Tiskilwa in the study area probably has a similar origin. The till unit was deposited during the Woodfordian between about 25,000 and 18,500 BP (Johnson, 1986), a time interval when the southern part of the Laurentide Ice Sheet was becoming progressively larger. As a result the gross dynamics of the ice sheet probably was relatively constant, and basal depositional processes were relatively uniform during the time interval.

We suggest that the uniformity of the Tiskilwa is primarily the result of (1) entrainment of similar materials from one or more relatively constant source areas; (2) adequate but not necessarily long-distance transport of basal debris; and (3) deposition at the base of the glacier, probably by lodgement. It is not clear whether homogenization took place primarily during transport or deposition or resulted from a combination of both processes.

Tiskilwa extent and depositional thickness

The major regional factors affecting ice sheet extent and distribution are climatic factors that account for net accumulation and ablation, which in turn determine mass balance conditions of the ice sheet. Local factors influencing ice sheet distribution include local topography, basal thermal regime, and shear strength of bed material.

The surface underlying the Tiskilwa Till at its margin now has an elevation of approximately 800 to 850 feet (244 to 259 m). Beyond the Tiskilwa margin (westward) the elevation of the surface of older tills and bedrock ranges from 800 to 900 feet (244 to 275 m). The regional bedrock slope toward the Lake Michigan Basin and the added wedgelike thickness of older glacial drift caused enhanced compressive flow in the marginal area of the Tiskilwa ice sheet. Because of these topographic conditions, the advance of the Tiskilwa



$\bar{x}$	37.1	38.1	24.8	$\bar{x}$	9.5	67.4	23.1	$\bar{x}$	2.0>
σ	3.4	2.8	2.9	σ	2.1	2.1	2.5	σ	2.5
n	49.	49.	49.	n	63.	63.	63.	n	63.

$\bar{x}$ = sample mean, s = standard deviation, n = number of samples.

Figure 9 Grain size and clay mineral data for boring NPC-2, McHenry County.

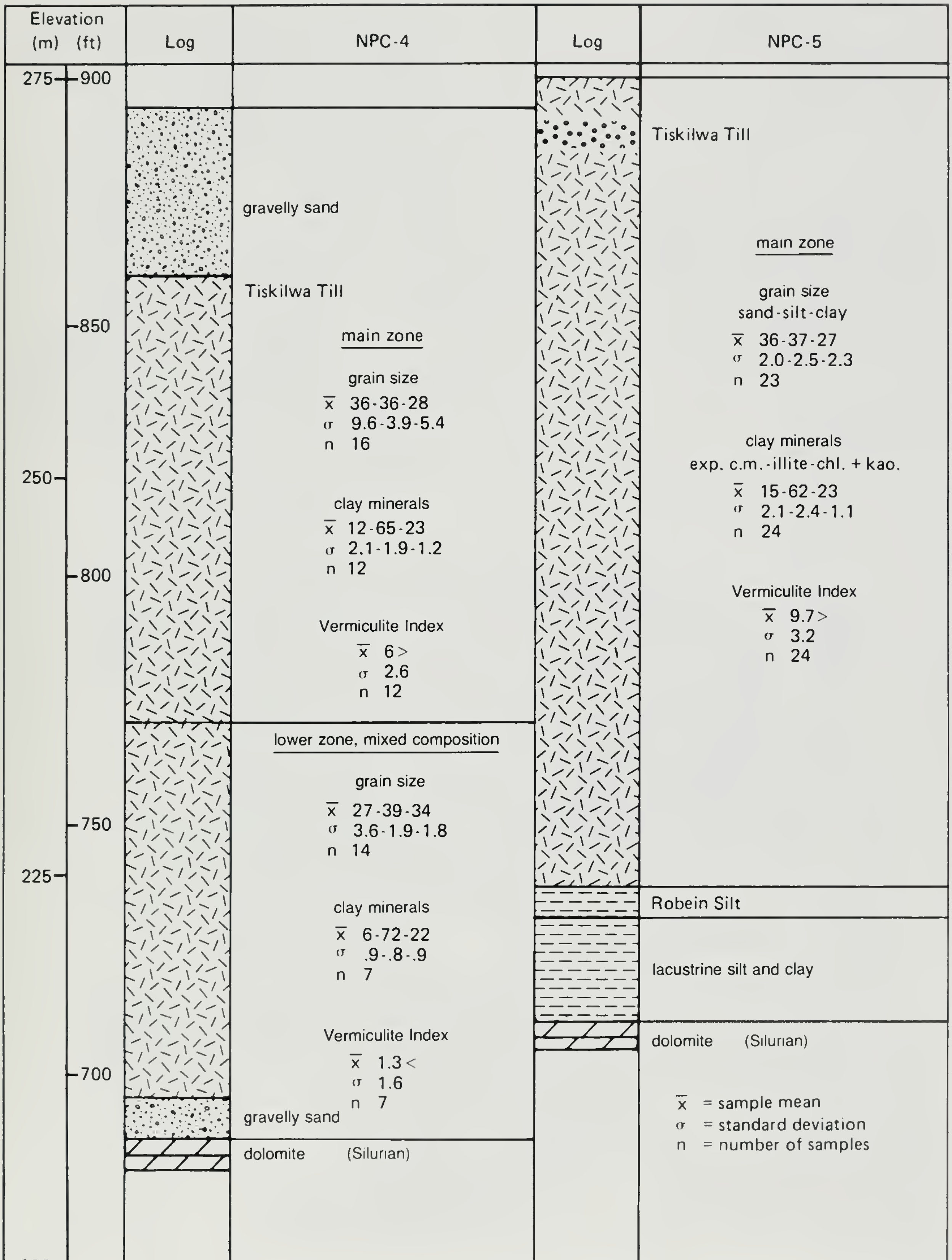


Figure 10 Average grain size and clay mineral data for borings NPC-4 and 5, McHenry County.

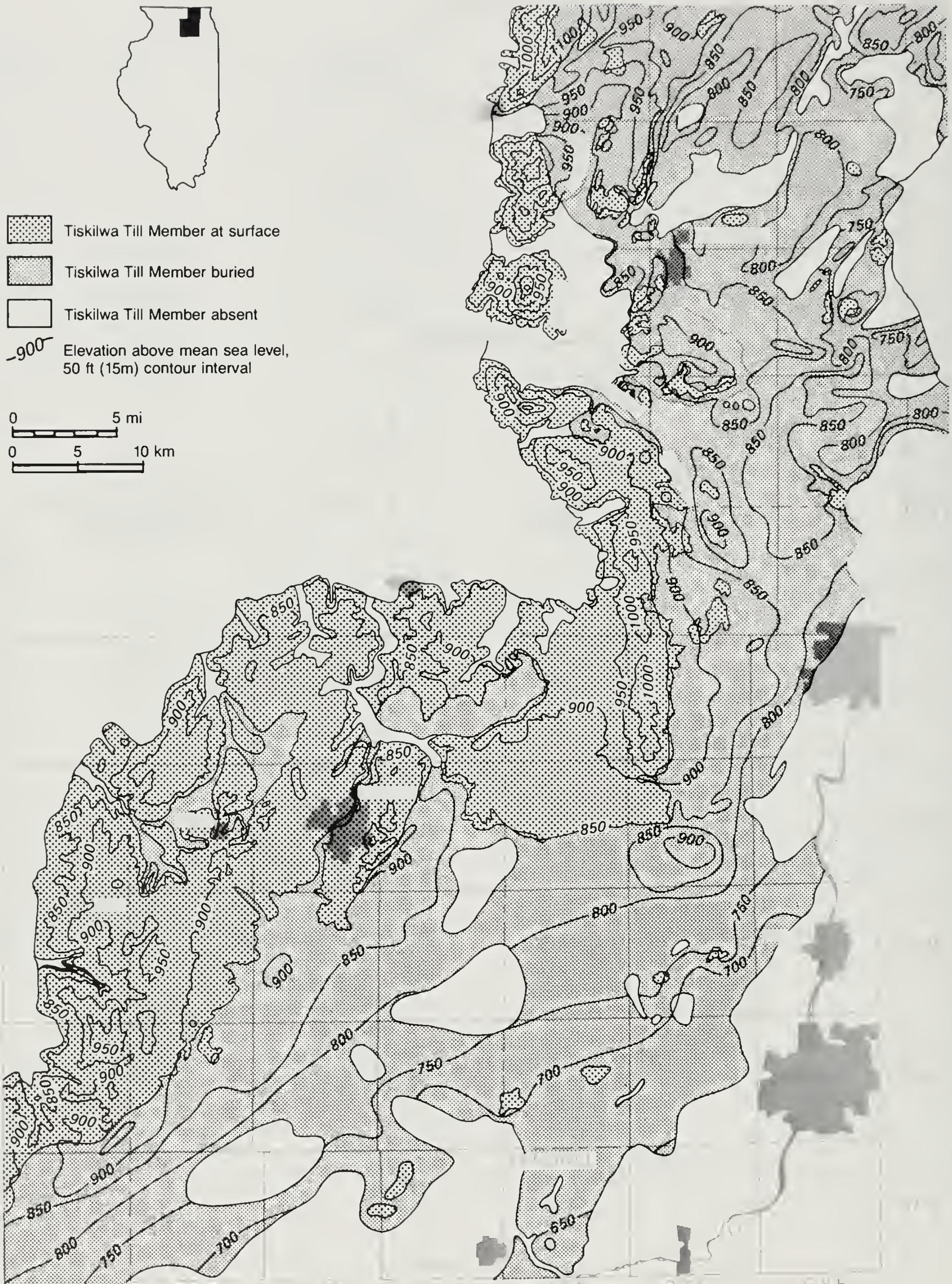


Figure 11 Topography of the Tiskilwa Till surface.

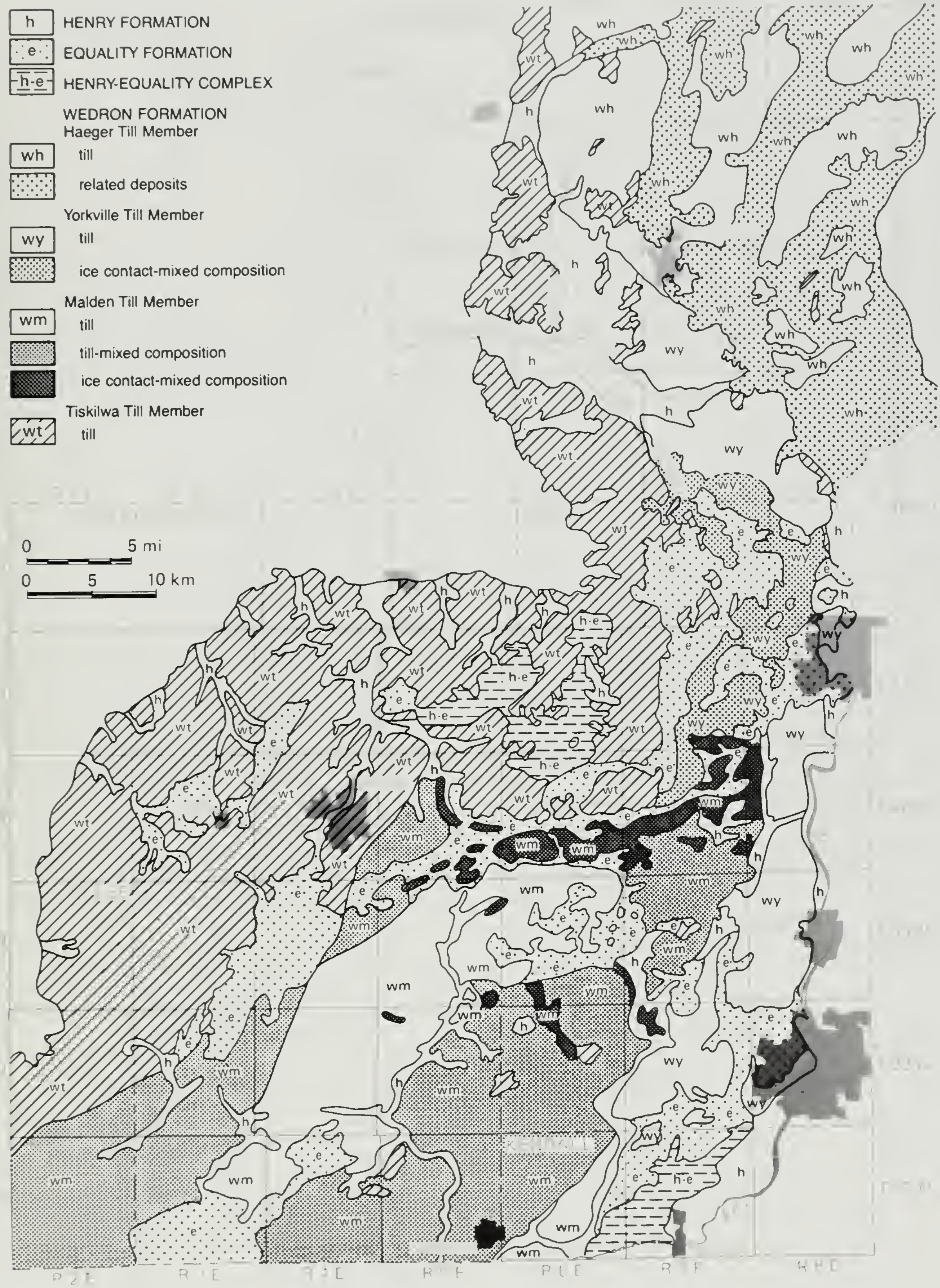


Figure 12 Surficial materials map (modified from Kempton et al., 1977, and Lineback, 1979).

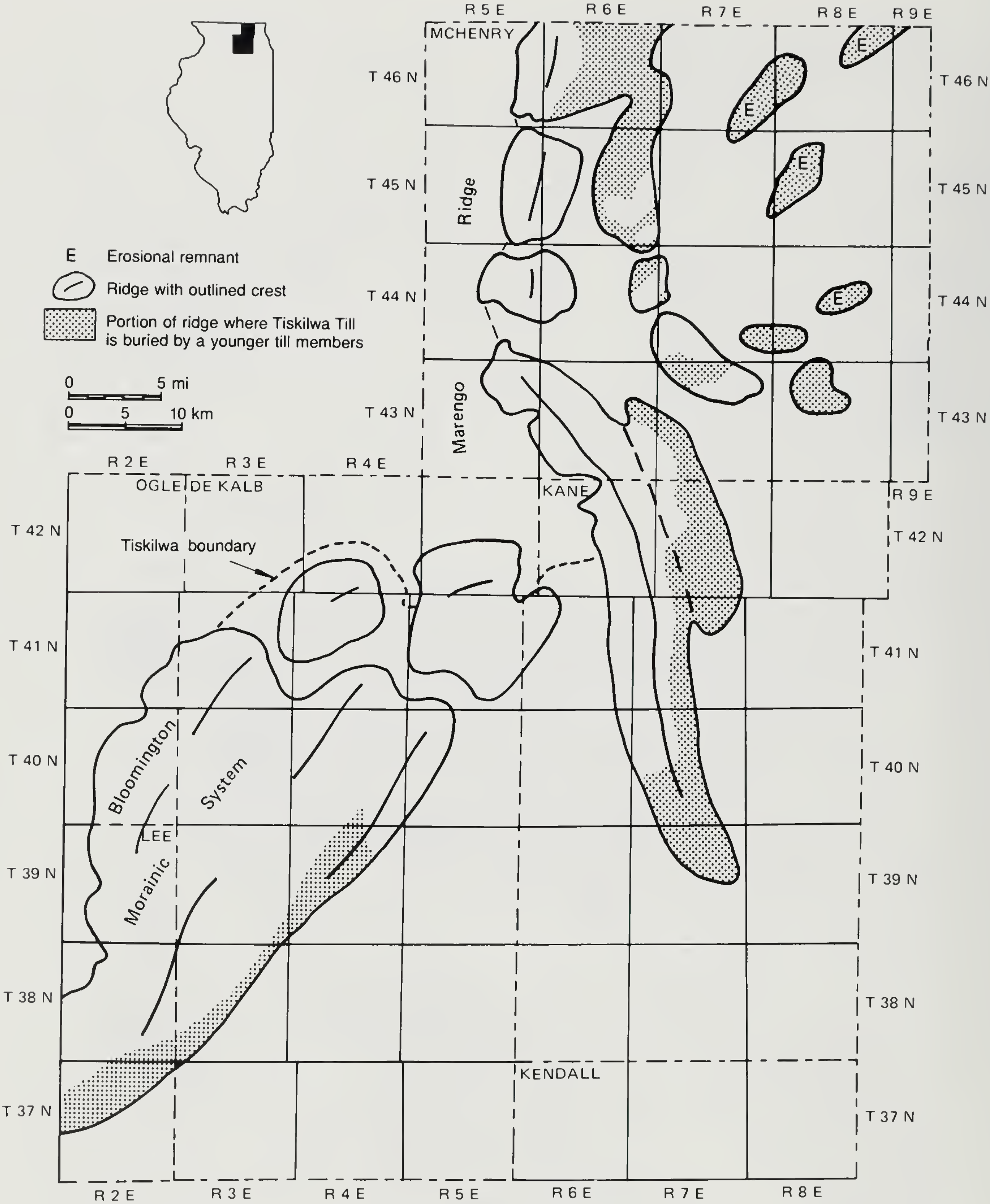


Figure 13 Major ridges composed of Tiskilwa till.

ice margin was more restricted in this area than in the central portion of the Lake Michigan Lobe in east-central Illinois. Thus, although the southern part of the Laurentide Ice Sheet generally had a positive mass balance during deposition of the Tiskilwa, the ice sheet margin in the study area was relatively stationary. Transportational shear stacking of ice and debris (Moran, 1971) at the relatively stable ice margin continued for a long period of time and allowed the unusually large thickness of Tiskilwa to accumulate. The ice sheet appears to have been in an active regime throughout this period as the Laurentide Ice Sheet became progressively larger. This long period of active deposition explains why the Tiskilwa is thicker than younger tills, and accounts for the dominance of basal deposition in the Tiskilwa.

Mickelson (1973) estimated from observations at a relatively inactive glacier that approximately 0.2 to 1.0 inches (0.5 to 2.5 cm) of till was deposited per year as basal meltout. If we assume that most of the uniform Tiskilwa till was deposited as basal till at an average rate of 0.8 inches (2 cm) per year, 150 feet (45 m) of till could have been deposited in 2,250 years. Till thicknesses of 300 feet (90 m), as in the Marengo Moraine, would have taken approximately 4,500 years to be deposited at this rate. The depositional rate depends on the debris content of the ice as well as on basal thermal conditions. A considerable range of values for basal deposition is likely and the assumed rate is used here only as a reasonable approximation.

The Tiskilwa ice sheet margin first advanced into northern Illinois about 25,000 BP; Tiskilwa deposition probably continued until about 18,500 BP (Johnson, 1986), allowing a period of some 6,500 years for possible deposition. Considering this time span, a 3,000- to 5,000-year period of deposition calculated from basal deposition rates fits the available evidence for duration of the Tiskilwa ice sheet in the area, particularly if deposition was not continuous in all areas. This interval represents approximately half of the Woodfordian Subage, and also represents the coldest part of the Woodfordian. Surface ablation probably was less and resedimentation processes were not as prevalent during this period as later during general deglaciation.

Tiskilwa morphology

Moraine patterns suggest a two-lobe system—the Princeton and Harvard Sublobes (fig. 3). Similar sublobes are seen in other moraine patterns in the Woodfordian and are related to regional ice flow within the Lake Michigan Lobe. The cause of sublobe differentiation is not evident in this area, but the uniformity of the sub-Tiskilwa surface perpendicular to the direction of ice flow (fig. 5) indicates that topography was not the controlling factor. The sublobes might have been caused by a topographic obstruction located farther up-ice, but none is known. Alternatively, the sublobe configurations may have been caused by interference with another major ice lobe, such as the Huron-Erie Lobe. The distribution of ridgelike features composed of Tiskilwa Till is shown on figure 13. Most of these features are thought to be of depositional origin, but their relief may have been emphasized or modified by later erosional processes. The outermost ridges are the Marengo Moraine and the Bloomington Morainic System. Other unnamed ridges occur in the subsurface; they are discussed in the section on till thickness.

The temporal and spatial relationships of the depositional ridges composed of Tiskilwa Till may be interpreted in several ways. Three possible interpretations were suggested by Leverett (1899): (1) The northern portion of the Marengo Moraine is contemporaneous with and a continuation of the Bloomington Morainic System, whereas the southern extension of the Marengo formed some distance back from the ice margin; (2) the Bloomington Morainic System is older than, and is truncated by, the younger Marengo Moraine; and (3) the Marengo Moraine is older than the Bloomington Morainic System, and the Bloomington ice sheet overrode the southern extension of the Marengo Moraine. The major relationship to be explained is the acute to right angle intersection of the Marengo Moraine and the Bloomington Morainic System (fig. 13).

The first interpretation, contemporaneous deposition, seems unlikely because it involves supplying ice to two adjacent sublobes, with significantly different inferred flow patterns, to form an active interlobate situation. The ice would have had to flow northward to the northern area of the Bloomington System from some central position in the Princeton Sublobe while the Harvard Sublobe intersected it with a north-south ice margin and westward ice flow. The glacial deposits do not support this hypothesis. Tiskilwa till in the Marengo Moraine is massive and continuous throughout its extent. The moraine's orientation to the south is definitely discordant with that of the Bloomington System. It does not contain (recognizably) large amounts of supraglacial material, such as are common in interlobate areas (e.g., the Kettle Interlobate Moraine in Wisconsin). In addition, available information on the sub-ice topography (fig. 5) indicates that there is no topographic reason for the development of the two sublobes with an area of interlobate deposition.

Willman and Frye (1970) supported the second interpretation (that the Marengo Moraine was younger than the Bloomington Moraine System) because of the apparent truncation of the Bloomington moraines by the Marengo. Leverett (1899) questioned this interpretation because he did not find an outwash plain off the southern extension of the Marengo Moraine. He reasoned that if the southern extension had been an ice-marginal position, there should be more evidence of meltwater drainage and outwash deposition. Another reason this interpretation is considered unlikely is that slopes in the southern extension of the Marengo are not as steep as those in the northern part, suggesting that the southern extension has been overridden and the slopes modified by later ice events.

These gentler slopes and the occurrence of buried outwash just west of the southern extension of the Marengo Moraine support the third interpretation that the Marengo Moraine is older than the Bloomington Morainic System. As shown diagrammatically (figs. 14a and b), the initial advance was by the Harvard Sublobe. The ice margin was only slightly arcuate and closely reflected the configuration of the Lake Michigan Basin. The two sublobes probably were not coeval; the Princeton Sublobe probably developed

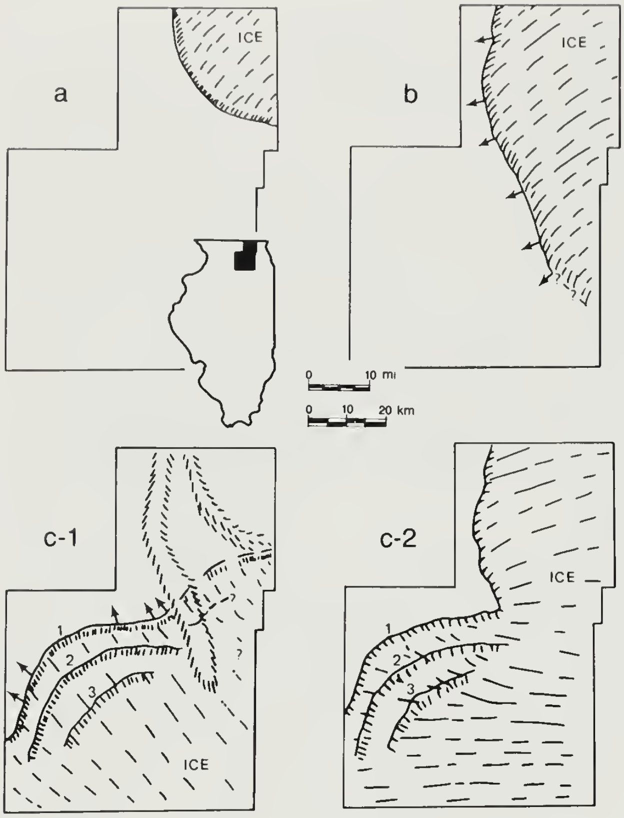


Figure 14 Formation of end moraines composed of Tiskilwa till: a, Advance of the Harvard Sublobe and possible formation of an end moraine; b, Further ice margin advance and formation of the Marengo Moraine; c-1, Advance of the Princeton Sublobe and formation of the Bloomington Morainic System (1, Shaws and Providence Moraines; 2, La Moille Moraine; 3, Paw Paw Moraine); c-2, Alternative interpretation involving both sublobes during formation of the Bloomington Morainic System.

and advanced into the area after ice margin retreat of the Harvard Sublobe (fig. 14c-1). The change in ice margin configuration may have resulted from the influence, to the east, of a coalesced Huron-Erie Lobe upon the Lake Michigan Lobe. Because the major lobes initially advanced about the same time (Dreimanis and Goldthwait, 1973), it would not be until sometime later that the eastern lobe would have advanced far enough southwest to have affected the Lake Michigan Lobe. Thus, the early configuration of the Woodfordian ice sheet closely reflected the outline of the Lake Michigan Basin just as it did in the late Woodfordian (e.g., during formation of the Valparaiso and Lake Border Morainic Systems) (fig. 1). During the middle part of the Woodfordian, the Huron-Erie Lobe probably diverted the southern margin of the Lake Michigan lobe to the southwest, resulting in the development of the Princeton Sublobe ice margin configuration. The large Marengo Moraine, particularly its southern part (fig. 14c-1), would have retarded ice flow and contributed to the angular relationships between the moraines.

A modification of this interpretation would involve ice from both sublobes during this event (fig. 14c-2). This latter scenario requires that the Harvard Sublobe not advance farther than the northern part of the Marengo Moraine, whereas the Princeton Sublobe flowed farther west over and around the southern Marengo. This interpretation appears less likely because of the acute reentrant angle between the two sublobes and the buried outwash west of the southern part of the Marengo Moraine. Minor fluctuations of the ice margin probably led to the formation of the individual ridges in the Bloomington Morainic System in either case (figs. 14c-1 and c-2).

Depositional features behind the Marengo (fig. 14c-1) may represent either: (1) an older Tiskilwa feature overridden by further advance of the Tiskilwa ice margin (fig. 14a); (2) a Tiskilwa end moraine deposited by the Harvard Sublobe during ice margin retreat; or (3) a marginal Princeton Sublobe feature (figure 14c-1). These ridges are difficult to interpret because they were overridden and erosionally modified by the Haeger and Yorkville ice sheets, and adequate subsurface data are not available for this area.

Younger till members

The Tiskilwa Till Member differs from younger tills in the area primarily in composition, character, thickness, and distribution. Two of the younger tills, the Malden and the Yorkville, reflect a dominant Lake Michigan Basin source; they are gray tills that contain more illite in their clay fractions than is found in the Tiskilwa clay fraction. The Haeger is much coarser than the Tiskilwa; it was derived primarily from Silurian dolomite along the southwestern margin of the Lake Michigan Basin.

The younger till deposits are much thinner than the Tiskilwa and do not form large depositional features in this area; they were formed over a shorter period of time and probably lost debris by meltwater erosion and subsequent resedimentation during deglaciation. The Malden, Yorkville, and Haeger Till Members overlap the backslope and only locally cross the large depositional features of Tiskilwa Till. The younger ice sheets generally did not advance over the formidable ridges before them. As the ice moved upslope, compressive flow was augmented, and debris probably was brought to the surface of thin marginal ice. Stagnation occurred and the results of differential ice ablation are readily seen in these younger till deposits and their surface morphology. These ice advances also produced more outwash than the Tiskilwa ice sheet did, and much of the debris has undergone resedimentation.

The duration of the deposition of the Tiskilwa was about twice as long as that for the Malden, Yorkville and Haeger Tills combined (Johnson, 1986). In addition, the Tiskilwa was deposited during a time interval when the southern margin of the Laurentide Ice Sheet had a positive mass balance and was actively expanding. The other units, however, were deposited during general deglaciation and shrinkage of the ice sheet. Thus, the dynamics of glaciation and the marginal climatic regime were different for these younger units, and the contrasting characteristics of these units are partly the result of these temporal changes during Woodfordian glaciation.

SUMMARY AND CONCLUSIONS

Study of the subsurface and composition of the Tiskilwa Till Member in a large area of northeastern Illinois indicates the following:

- The Tiskilwa is a wedge-shaped deposit 200 to 300 feet (60 to 90 m) thick at the western margin and 50 to 100 feet (15 to 30 m) thick behind this margin; its thickness decreases to the east and southeast toward the Lake Michigan Basin.
- The composition of the Tiskilwa Till Member is relatively uniform throughout the region, except for a supraglacial till facies and till in its lower zone. The supraglacial till facies and lower zone are recognized as an integral part of the unit defined as Tiskilwa Till. Supraglacial till is associated with sorted deposits and varies considerably in thickness, distribution, and character throughout the region. The lower zone of the Tiskilwa is discontinuous; it is the result of local incorporation of bed materials and dilution of the typical Tiskilwa composition.
- The Tiskilwa was deposited during several depositional events that occurred over a relatively long period of time during which the Laurentide Ice Sheet was getting progressively larger. During the long period of ice activity, a large thickness of Tiskilwa Till accumulated at or near the ice margin, forming large end moraines and associated ground moraine.
- Local topographic factors influenced marginal Tiskilwa ice conditions. The gradual, regional westward rise in elevation of the sub-Tiskilwa surface caused a compressive flow regime in the ice margin. Large amounts of ice and debris were stacked near the ice margin during several depositional episodes.
- Subsurface data indicate that the formation of the Harvard and Princeton Sublobes and the right angle reentrant between them was not controlled by topography, but that the two sublobes probably are the result of temporal variations in the effect of the Huron-Erie Lobe upon flow of the Lake Michigan Lobe.

The initial Woodfordian advance of the Lake Michigan Lobe (Harvard Sublobe) in Illinois was not affected by the Huron-Erie Lobe; later, however, the Huron-Erie Lobe probably deflected the Lake Michigan Lobe, which resulted in the greater westward advance of the Princeton Sublobe. Thus, the two sublobes probably did not exist at the same time but are the result of temporal variations in the configuration of the ice margin.

- Several depositional events are suggested by the subsurface maps. The maps reveal thick deposits of Tiskilwa Till that have morphology and orientations similar to ice-marginal accumulations. The Tiskilwa surface morphology influenced later ice events and many palimpsest end moraines developed with a core of Tiskilwa Till.
- The younger till units in the area have complex relationships to each other and to the underlying Tiskilwa Till. In a large part of the marginal area, these younger deposits have compositional variations due to the incorporation of older sediment (mostly Tiskilwa till) and variable modes of deposition. These units were deposited in a relatively short time during general deglaciation. Supraglacial and ice-marginal resedimentation processes were more active at this time than during deposition of Tiskilwa Till.

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APPENDIX

Table A Enumeration of data sources

County	NPC	ISGS	NWT	EWT	HWY	ww-data ww-tot	Misc. cores
Mc Henry	10	—	3	—	2	11/56	12
Kane	8	8	28	15	100	22/63	4
De Kalb	1	6	—	20+	40	21/77	27
Kendall	1	1	—	—	3	4/7	5
Lee	—	7	—	—	3	3	—
Ogle	—	1	—	3	6	11	—
TOTAL	20	23	31	38+	154	58/217	48

Well logs without samples and field notes of hand auger, shallow borings and outcrops have been utilized but are excluded from this tabulation. All logs and samples are on open file at the Illinois State Geological Survey, Urbana.

Explanation of Abbreviations:

NPC—Cores drilled for water resource evaluation by the Northeastern Illinois Planning Commission.

ISGS—Cores drilled for water resources evaluation for the Illinois State Geological Survey.

NWT—Cores drilled for the Northwest Tollway, stratigraphic and engineering testing.

EWT—Cores drilled for the East-West Tollway, stratigraphic and engineering testing.

HWY—Cores drilled for highway, bridges and foundations, stratigraphic and engineering testing.

ww-data—water well sample sets (ISGS) with analytical data.

ww-tot—total water well sample sets studied, includes those with data.

Misc. cores—mainly stratigraphic test borings (core), done by the ISGS and SCS, does not include outcrop and hand auger samples.

Table B Radiocarbon dates related to Robein Silt in and near study area

County	Location Sec, T-R	Radiocarbon date	Identification	Unit
Cook	28,T42N-R9E	25,300 ± 2100-1950	I-2783	Robein Silt
Kane	1,T40N,R8E	26,890 ±400	ISGS 1113	Robein Silt
Kane	2,T42N,R8E	37,600 ± 1300	ISGS 238	Robein Silt
Kane	4,T40N,R8E	35,300 ± 1400	ISGS 1275	Yorkville T.M.
Kane	3,T40N,R8E	>37,000	ISGS 1320	Robein Silt
Kane	7,T41N-R7E	41,000 ± 1500 (re-run I-848)	GrN-4408	Robein Silt*
Kane	7,T41N-R7E	>40,000	I-848	
Kane	11,T41N,R6E	38,600 ± 3200	ISGS 1295	Robein Silt
Kane	11,T41N,R6E	27,250 ± 340	ISGS 1296	Robein Silt
Kane	11,T39N,R8E	>50,000	ISGS 1245	Robein Silt
Kane	13,T42N,R7E	25,230 ± 570	ISGS 127	Robein Silt
Kane	15,T39N-R7E	32,600 ± 520 (re-run I-1197)	GrN-4468	Robein Silt*
Kane	15,T39N-R7E	>40,000	I-1197	
Kane	15,T40N-R5E	39,000 ± 1300	I-124	Tiskilwa T.M.
Kane	18,T42N-R7E	26,900 ± 1300-1600	I-1625	Robein Silt
Kendall	1,T37N-R6E	>36,000	I-1626	Robein Silt*
		40,360 ± 1400	I-559	
		40,480 ± 1070	I-557	
McHenry	12,T46N-R5E	38,000 ± 3000	I-847	Robein Silt*
McHenry	15,T45N-R6E	25,600 ± 800	I-849	Robein Silt
McHenry	30,T43N-R8E	25,300 ± 1100	I-1624	Robein Silt
Ogle	1,T41N-R2E	23,750 ± 1050-950 (combined sample)	I-2784	Robein Silt

*originally interpreted as Plano Silt Mbr, Winnebago Fm.

Modified from Kempton, J. P., R. A. Bauer, B. B. Curry, W. G. Dixon, Jr., A. M. Graese, P. C. Reed, M. L. Sargent, and R. C. Vaiden, 1987, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Results of the Fall 1984 Test Drilling Program: Illinois State Geological Survey Environmental Geology Notes 117, 102 p.

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